E.T.A.

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THE

TEA QUARTERLY

THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

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THE TEA RESEARCH INSTITUTE
St. Coombs, Talawakele,
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It is particularly requested that letters should not be addressed to officers by name. Specimens and other consignments sent by rail should be forwarded to Talawakele Station, c/o Messrs M. Y. Hemachandra & Co., Ltd., Forwarding Agents. *Carriage should be pre-paid.*

Low-country estates should address their correspondence and enquiries to the Low-Country Adviser, T.R.I., Planters' Club, Ratnapura.

Visitors' Days.—The *second* and *last* Wednesdays in each month have been set aside for Visitors' Days at St Coombs Estate and also at the T.R.I. Sub-Station, Gonakelle Estate, Passara, when it is hoped that those interested will visit the stations.

Guest House.—The house formerly used for guests is now an officer's residence and it is regretted that, for the time being, no Guest House facilities are available. Those visiting the Institute or the Estate on business, who are unable to arrange accommodation in the neighbourhood, should seek the help of the Director.

Publications.—The *Tea Quarterly*, Bulletins (New Series), Pamphlets, and Annual Reports, published by the Tea Research Institute will be sent free of charge to Superintendents of Ceylon tea estates over ten acres in extent and to estate agencies dealing with Ceylon tea, if they register their names with the Director, Tea Research Institute of Ceylon, St Coombs, Talawakele.

Other persons can obtain the publications of the Institute on application to the Director, the post-free subscription being fifteen rupees per annum for persons resident in Ceylon or India and £1–5–0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2.50 or 4*s*. Indian cheques should have four annas added to cover commission.

THE TEA QUARTERLY

Vol. 32 March, 1961 Part 1

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EDITORIAL

The Twelfth Biennial Conference of the Institute was held at the Savoy Cinema in Colombo on January 20th and 21st, 1961. Nearly 600 people attended the Conference, including about 450 Ceylon planters.

We are grateful to planters and others who have expressed their appreciation of the Conference. For our part, the scientists who gave talks were greatly encouraged by the interest displayed by the audience and by the large number of questions asked. It was not possible to answer all of the questions in the time available, but they are being answered in the *Tea Quarterly* after the papers to which they refer.

One failing of which we are aware was that the use of the loud-speaker system was not always successful. Steps are being taken immediately to order a breast-set microphone so that this weakness shall not occur at the next Conference.

Not all the papers read at the Conference are being published in this issue of the *Tea Quarterly*; they have been divided between this March issue and later numbers. The programme (*see* next page) indicates which papers will be published later. Some of the papers were shortened for the Conference and will be presented in full in the *Tea Quarterly* so that more detail and references to literature will be available in the permanent record.

TEA RESEARCH INSTITUTE OF CEYLON

TWELFTH BIENNIAL CONFERENCE
HELD AT THE SAVOY CINEMA, COLOMBO

PROGRAMME

Friday, January 20th

9-00 a.m. Introduction by the Chairman of the Board of the Tea Research Institute of Ceylon, Mr Francis Amarasuriya.

Opening Address by the Hon'ble C. P. de Silva, M.P., Minister of Agriculture, Land, Irrigation and Power, and Leader of the House of Representatives.

Dr D. L. Gunn, C.B.E., Director, T.R.I.—Review of recent events and prospects.

Mr J. A. H. Tolhurst, Agricultural Chemist—Organic matter in Ceylon tea soils.

*Dr A. W. R. Joachim, O.B.E., Low-country Adviser—The shade-tree question and green manures.

*Dr T. Visser, Plant Physiologist—Some complications on shade and cover crops.

2-00 p.m. Dr E. Judenko, Entomologist, Special Research (Shot-hole Borer)—Control of Shot-hole borer (*Xyleborus fornicatus* Eichh.): Experiments in progress.

Mr J. E. Cranham, Entomologist—The natural balance of pests and parasites on Ceylon tea, especially Tea Tortrix and *Macrocentrus*.

*Dr D. Mulder, Plant Pathologist—How to economise on blister-blight control: decisions based on sunshine recording.

*Mr A. L. Elias, Superintendent, St Coombs—How to economise on blister-blight control: motorized mist-blowers.

*Dr A. W. R. Joachim, Low-country Adviser—Responses to manuring in various low-country conditions.

Mr A. L. Elias, Superintendent, St Coombs—Nursery management.

Saturday, January 21st

9-00 a.m. *Dr D. Mulder, Plant Pathologist—Organic matter and parasitic fungi.

*Mr C. B. Foster-Barham, Chief Advisory Officer—Advisory work and the tea planter.

*Dr T. Visser, Plant Physiologist—Shade and manuring.

Dr D. Mulder, Plant Pathologist—A preliminary investigation of the problem of maintenance-leaf fall in the low-country.

*Dr M. T. Hutchinson, Nematologist—Developments in the control of Meadow Eelworm.

*Planters' discussion.

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*Note:— The papers which are starred will appear in later numbers of the Tea Quarterly. The planters' discussion questions are being distributed to the relevant papers.

CONFERENCE—PROCEEDINGS

INTRODUCTION BY F. AMARASURIYA, Esq., CHAIRMAN OF THE BOARD OF CONTROL OF THE TEA RESEARCH INSTITUTE

It gives me great pleasure, as Chairman of the Board of Control of the Tea Research Institute of Ceylon, to extend to the Hon'ble Minister of Agriculture, Land, Irrigation and Power, Mr C. P. de Silva, on behalf of the Tea Research Institute and the tea planting community of the Island, a warm welcome to this Conference.

We are meeting for the 14th Conference, if we include the special symposia on Shot-hole Borer and on re-planting. The second conference was held at St Coombs in 1931, when the laboratories were opened, and about 200 planters attended. In the 30 years since then, our conferences have far outgrown any accommodation that can be provided up-country. In 1953, we had to hold it twice, once in Colombo and once in Nuwara Eliya; and our Shot-hole-borer Conference at Ratnapura in 1956 had to be limited by invitation. This year, in order to get everyone in at once in a town which could accommodate 600 visitors, we had to come to Colombo. This has meant a long journey for some of you, but I hope you will, at the end, feel that it has been worth while.

It is my pleasant duty to welcome a number of distinguished visitors, former Ministers of State and also present Ministers. We are also glad to see a representative selection of the members of the House of Representatives. I understand that they will have to leave us shortly, because the House is meeting. From overseas we welcome Mr N. G. Gokhale, Director-elect of the Tea Research Station at Tocklai in Assam; and Mr Ananda Rau, Chief Scientific Officer, Scientific Department of the United Planters' Association of South India. During the discussion, we hope to hear from them and to have the benefit of their experiences.

I am also pleased to welcome the representatives of Government Departments, sister Research Institutes, and other interested organisations in the country who have responded to our invitation.

Finally, I have to welcome our Visiting Directors from London, representatives of the Planters' Association and of its Agency Section, of the Low-Country Products Association, and of the District Planters' Associations, and to thank them all for their attendance at this Conference.

I will now, Sir, ask you kindly to declare open this Conference and to address us.

OPENING ADDRESS BY THE HON'BLE C. P. De SILVA, M.P., MINISTER OF AGRICULTURE, LAND, IRRIGATION AND POWER, AND LEADER OF THE HOUSE OF REPRESENTATIVES

Mr Chairman and Gentlemen, it gives me great pleasure to address you. You are the men who, in your daily work, are responsible for a large part of the prosperity of Ceylon. As far as exports are concerned, your contribution is about twice as great as the contributions of all other exports put together. I may not agree with my distinguished predecessors at all times, in all places, and in all matters; but in this matter we can whole-heartedly agree.

The total *production* of tea in Ceylon passed the 300 million pounds in 1949, and it passed the 400 million pound mark in 1958; and we are still rising. I have been told just now that the quantity of tea *exported* in 1960 was over 400 million pounds. In fact, not only is the poundage of tea exported rising, but also the proportion that it contributes to our foreign exchange is rising. We are doing our best to diversify Ceylon's production and trade, but for the present and for some time to come, the prosperity of the Island will lean heavily on the production and export of tea.

Looking back over the life of the Tea Research Institute, and of the Industry, the older ones among us will remember the bad times of the World Slump in the 1930s. Even then tea was less affected than other exports. There are so many people in the world who drink tea, which is a cheap drink and is not attacked by any prohibitionists, that we may expect such stability. But what of the future? There are signs, as yet only faint and perhaps misleading, of world economic trouble coming. Today we do not call it a slump; the word is too awful to those who experienced the 1930s; we call it a recession. And many believe that that great economist, J. M. Keynes, has shown us how to control recessions. But control may not be perfect and the world may run into economic trouble again. Are we geared to meet that? Are we geared to meet a slump in the tea market?

You may think that I am being pessimistic. But we in Government have not only to build up and plan for the best; we have also to guard our defences against the worst. I do not say that we are going to have a slump; what I ask is, if a slump in tea did come, how should we meet it? But why might there be a slump in Ceylon tea? There are two possible reasons. The first is the result of people all over the world not wanting to take a bit of trouble. If they want some coffee they just take a spoonful of Nescafé, and some warm water—and simply swill out the cup afterwards. They do not any longer roast the beans, grind them, percolate and then find some place to put the grounds. You may think people are getting lazy. But you cannot laugh this one off. The customer is always right. Soluble extracts have come to stay. How does this affect tea? Soluble tea is on the American market—a good market for tea, second only to Britain—and soluble tea made in U.S.A. is not likely to encourage greatly the sales of the traditional high-quality Ceylon teas. The success of a soluble powder tea might very well reduce the demand for Ceylon teas, and so cause a price fall, which would be a serious matter.

What are we doing about this? We, too, must get into the soluble-tea trade and, here again, build up a reputation for quality. The T.R.I., in collaboration with the Ceylon Institute of Scientific and Industrial Research, has done the basic research on a soluble tea made direct from green leaf. Unlike soluble teas already on the market, it actually tastes like tea! This is a very important matter and is surely the start of a new development in the tea industry. I have been able to give some thought to it and I have decided to utilise a million or one and a half million rupees to set up the first soluble tea factory in the Island using the medium of the State Plantation Corporation. I also consider that this factory should be located somewhere in the mid-country and thereby help the mid-country tea producer who is so much in need of assistance today.

We have to corsider other matters than changes in consumption. We have to consider changes in production too. Broadly speaking, the forecast for the next five years is that there will probably be a reasonable balance between production and consumption. And the Ceylon Tea Propaganda Board is doing well in ensuring that Ceylon gets a good share of the market. But we are concerned about what our friends in China may do. To the best of our knowledge they had replanted in the few years before 1955 about 100,000 acres; and we do not know how much they have done since then. No doubt some of the more recent additions will contain the best Ceylon clones, which one of my predecessors directed to be sent to China. I have now banned the export of all tea clones and seeds from the Island. The results of these enormous plantings are beginning to come on to the world market. Exports from China are approaching 100 million pounds, though only 10 million went to London in 1959 and that was mostly of poor quality. An F.A.O. forecast suggests that China will put on the London market in the next few years 120 to 150 million pounds per annum, and that nearly this amount will be surplus to consumption. That could cause a catastrophic fall in price in the grades concerned, with serious effects in Ceylon on employment, exchange revenue, and tax revenue. What should we do to meet this? We should emphasize quality; and for those grades of tea that cannot be improved to above China level, we should change over to soluble tea.

That is enough of being pessimistic. Whether China exports a lot of tea or not, we must make soluble tea, and start soon, before the market is too crowded.

If you are pessimistic about our future competitive position in world markets, you may feel that it is a mistake to increase your production. That is not so. The forecast that I gave you, from F.A.O., was based on Ceylon replanting 30,000 acres with high-yielding clonal tea, with three times the old yields. Actually estates have so far been paid the first subsidy instalment on only 3,074 acres, so there is plenty in hand. We have collected money from your sales of tea and we are eager to give it back--if you replant. So that is up to you. With replanting and other improvements, the amount of extra tea that the Island can produce and the market can take, if we keep ahead in quality and in soluble tea, is considerable and we envisage reaching 500 million pounds in export by 1968.

I do not say that all of this should be conventional tea. A great part of it should be soluble tea, if we are going to move with the world. And that raises the question of capital. I understand that about two-thirds of your costs do not vary much with the size of your crop, and one-third is proportional to crop. That is to say, if you increase your crop by 10%, your cost of production per pound should go down by 6%. This will naturally help you to keep the estate's head above water if there is a fall in prices. If, however, your crop gets so big that you have to build a new factory or at least put in extra machinery, the position is quite different. You have to find new money for capital. That is a great problem in

Ceylon today. I know that we eat heavily into your profits by taxation. I know that of the Rs. 1,000 million obtained from export of tea, we collect Rs. 200 millions or more before you get a chance of profits, and then we tax the profits too. But the country cannot do without these taxes. In spite of taxes some estates are replanting heavily. What about you? We know that most mid-country estates certainly cannot afford to provide any capital and, for them, we hope to induce overseas capital to come in and put up factories for soluble tea. But for the rest, the position is surely better. If you are concerned at overloading your factories and so spoiling quality, what can we do to help?

I have already given assurances to your Chairman that Government will lend you the money to buy a Low-country Sub-station, as arranged by one of my predecessors, and will help you to acquire the land, if that becomes necessary. What else do you want?

I wish to draw your attention to two new developments which have taken place after 1956. First the State Plantations Corporation which has been created by Act of Parliament. This Corporation has already begun the planting of the first State-owned 1,000 acre tea property at Pelawatte in Pasdun Korale, east of the Kalutara District. This plantation, I have been assured by the Honourable Senator Sarath Wijesinghe, will soon become one of the finest tea properties in the Island if not the best. Secondly, the setting up of many peasant tea colonization schemes in the Galle, Matara, Kalutara, Ratnapura, Kegalla and the Kandy districts. In these colonization schemes a peasant family gets a 2-acre lot for planting tea and a half-acre block for his home and garden. The 2-acre tea lots are grouped together to form a 500 or a 1,000-acre block of tea; and the half-acre garden lots are grouped together to form villages, each containing about 200 families which are provided with such facilities as schools, dispensaries, etc. The establishment of these peasant colonization schemes is a controversial subject and an attempt has been made to overcome many of the difficulties which have been envisaged. Very substantial financial assistance is given by the Land Commissioner's Department which is in charge of these colonization schemes of the peasants and they are given all the technical assistance and are strictly supervised by the officers of the Land Commissioner's Department. I am glad to say that my Ministry has been greatly helped by members of the tea industry who function as Visiting Agents of these schemes and thereby have helped considerably in their development. According to the reports received at the Ministry these schemes are doing quite well. The tea factory of these schemes will be co-operatively owned by the peasant allottees and in the first instance controlled by the State Plantations Corporation.

By these developments you will find State-owned plantations as well as co-operative plantations competing with private enterprise. By this process we are trying to utilize both private enterprise and State enterprise of a planned economy as best as we can to serve the needs of the country and to make these two forms of enterprise compete with each other on the basis of equality. Personally I have no strong likes and dislikes in this matter. I am prepared to establish co-operative as well as collective plantations in addition to State-owned plantations if the people of this country wish to have them. I shall neither force these types of cultivation on the people nor shall I ban them. From experience so far gained I find the peasantry do not favour either co-operative or collective schemes and instead prefer to own their individual allotments while collectivizing the agricultural process, for example, the manufacture of tea under co-operative management. I have also examined the economic side of these peasant colonization schemes. I find that if we get a thousand pounds of made tea per acre per annum, which I am assured we can do, the Government will recover the assistance given to a farmer in six or seven years by collecting the export duty on the tea he produces. By this method we are

converting landless peasants, who are a liability to the State, into earners of foreign exchange who will make a considerable contribution to the revenues of the Government.

I have spoken to you on the broad policy, because that is my business. I realise that, however well you may continue to do your work, if national policy is against you, you will be frustrated. Similarly if you were all careless in your work, no policy of Government's could make up the loss. The Tea Industry and the Government must work together for the prosperity of the Island and the Nation. Working together, we can make Ceylon happy and prosperous.

REVIEW OF RECENT EVENTS AND PROSPECTS

Dr D. L. Gunn, C.B.E.
Director, T.R.I.

Mr Chairman, Hon'ble Minister, Members of the House of Representatives and of the Senate, gentlemen of the tea industry, it is a pleasure to see here today so many of the men whose daily and detailed work, whose skill and devotion, sustain the economy of Ceylon. It may not be generally realised, in the world outside, that the production of tea is not an easy task. The tea tree has been domesticated, but only to a slight extent; it has been turned into a bush and made to do things that *we* want it to do, *not* the things that it would do in nature. If we slacken off, the jungle is quite ready to take over. And there are plenty of cases in history where people have taken a wrong turning and the jungle *has* taken over. Progress on the upward path is not inevitable; it depends on a constant striving and a wise-choice of the way to go. Tea cultivation is like pushing a big ball up a hill; the moment that we stop pushing, down it goes again. We cannot stay still; we must go forward, or we shall certainly fall back. And in deciding how to push and where to go, we must use all the information, all the experience, all the wisdom that have accumulated, not only in Ceylon but in the whole world. It is a great pleasure and an honour for me, to be working in this important and progressive industry, where many people are constantly striving to do better, and to solve the problems that beset the country.

I understand that it is customary at these Conferences for the Director of the T.R.I. to summarise the events of the previous two years. I am not going to bore you with a recital of facts that you already know; but I take the opportunity of mentioning a few things about the T.R.I. itself.

First of all, before the T.R.I. can serve the tea industry as it should, it must have the right sort of men, the equipment and buildings, and it must have the money. As you know, during the 1950s the T.R.I. went through difficult times. Most of the senior officers left, new ones tended not to stay long, and those who did stay had to do many kinds of work. Then the Chairman, Mr Francis Amarasuriya and the Board of the T.R.I. got to work on reorganisation and we got Dr Joachim. Today in most cases, each Division is headed by an experienced senior officer, though there are still some vacancies; and most Divisions have at least one officer of Intermediate Grade.

This new Intermediate Grade, entirely recruited in Ceylon, contains young men who are the leaders of the future. In the Scientific Divisions we have 9; at the present time, 4 of them are overseas for further training; but we also have 10 vacancies. During the past two years, we have gained 4 and lost 3, so the position is not easy. The trouble is that, for these young scientists with a good Honours degree, the demand in Ceylon exceeds the supply; and we are competing with the Department of Agriculture, the other Institutes, industry, and the University itself. But we are going on trying. And because we hope that the seniors of the future will be chosen from the Intermediate Grade, we are selecting these young men very carefully. We want nothing but the best.

In the senior staff, we have done rather better in numbers. One—Mr Austin—has retired and has been replaced by Mr Cranham, previously working in West Africa. We have gained Dr Hutchinson, lent by the United States Operations Mission (U.S.O.M.) who has put a new drive into work on eelworms, Mr Foster-Barham, from the Tea Research Institute of East Africa, who has opened the new Advisory Division, and myself. More are coming, one in Agronomy, for field trials, and we hope one in Statistics, for the same purpose. We are waiting for the Statistician to be released by Government.

The new Advisory Division is intended to take the main load of advisory work off the Research Divisions, and it is already doing that. But we envisage considerable expansion in the future, as we get and train the staff. At present, two junior officers of the Advisory Division are being trained overseas, there is a vacancy to be filled, and Mr Foster-Barham is working alone. We will remedy that position as soon as possible.

As far as the low country is concerned, advisory work continues to be done by Dr Joachim, after his diversion to directing the Institute from St Coombs. In addition, Dr Joachim has worked very hard on the choice and purchase of an estate for a Low-country Sub-station. It now looks as if our search for suitable tea land is over, but I cannot say more than that at present.

This increase of senior and intermediate men costs money, not only for their own salaries but also for their junior assistants, their houses, and their laboratories. To a large extent, the buildings are being put up with money accumulated during the 1950s, when we could not get staff and could not spend the money wisely. Today, the position is quite different. In the last two years, our current expenditure has risen until it now exceeds our income. The industry wanted this expansion of our activities and everyone concerned agreed to pay for it by an increase in the Tea Research Cess from 55 cents to Re 1/- per 100 lb. of tea exported. Unfortunately, Parliament has not yet had time to make this into law, so we have been living and building at a one-rupee level with a 55-cent income. Consequently, our reserves are melting away and every month that passes means a greater loss of reserves, a loss that can never be made up without a further increase of cess. We can only hope that Parliament will be able to find a few moments for this non-controversial measure soon, before we actually run into debt.

You may well say that an increase in staff and in costs does not necessarily give an increase in production. Our position is this. In 1925, when T.R.I. began, and 1930 when the laboratories were opened at St Coombs, the scientific investigation of tea production in Ceylon had not gone far. It was almost an unexplored subject. And when one first begins to explore, big discoveries can readily be made. But when the big discoveries *have* been made, one has to go into far more detail to produce worth-while results. To progress at the same rate, more men are necessary. And as exploration proceeds, more and more problems are revealed, of whose existence nobody previously knew.

As for the work we have been doing, the other speakers will tell you something about that. There is only one feature that I want to draw your attention to. During the past year, we at the T.R.I. have been very actively discussing five interrelated matters, and the same five matters have been discussed by our Scientific Advisory Committee in the U.K., of which Dr Tubbs is Chairman. They are:

1. clonal selection;
2. density of planting;
3. topiary or wedge pruning;
4. elimination of inter-planted crops, such as shade trees; and
5. fertilizer levels.

These are subjects which arouse thoughts and emotions in all our minds, subjects about which we all have opinions. But what we must now discover is: what are the facts? It seems possible that a new break-through in high yields can be produced in some cases, by choosing the right clones, planting at high density, wedge pruning, cutting out all shade, and using very high fertilizer levels. I say that this seems *possible;* but it is *not certain* and the complications have to be worked out. Already, we can foresee some snags. During the papers that will shortly follow, Dr Joachim will put one point of view and Dr Visser another. In this way we hope to take you inside and show you some of the machinery of scientific discussion in the T.R.I. Naturally, some of the differences will be exaggerated to make the picture clearer. But remember, the picture is not yet clear to us or to anybody. All of these five things are being tried somewhere in the Island. We have to get down to statistically planned trials, to show their effects, quantitatively, and in particular to show how one change effects another.

Now I have said a little about the addresses that we shall hear, today and tomorrow. But there are gaps. I have been asked—why is there to be nothing about manufacture and nothing about biochemistry? The answer is in two parts; it is not desirable to tell you again things that have been written in the *Tea Quarterly*, sometimes things that are too complex for a conference of this size; and second, I have tried to arrange a programme of short papers from each of which everyone can take away something; rather than use up every minute with talk from the platform, I have allowed time for questions and discussion. It would be a great help if these questions could be put on paper and passed up, giving also the name and estate of the questioner, so that we can keep the record straight.

That is all I will say now about the T.R.I. And now a few words about the prospects of the industry as a whole, especially in relation to the needs of this beautiful island of Ceylon. You may think it impertinent of me, a newcomer to the Island, to talk about the future of Ceylon. But the T.R.I. is part of the tea industry; and the Island is dependent on the export of tea, to sustain its economy and its standard of living. I have to think about these things, in order to help the Board to decide where the T.R.I. is going, which research projects it should go in for, and which researches should be dropped.

The population of Ceylon has now passed the 10 million mark. A careful published analysis shows that, unless something dramatic happens to the birth rate or the death rate, we shall pass the 20 million mark in 1980, or 1983 at the latest. In about 20 years from now, there will be twice as many mouths to feed. And from now on, the babies already born will be coming on to the employment market, at first at a rate of 120,000 extra each year, and later at much higher rates. All the economists who have studied this question agree that a fall in the standard of living is inevitable *unless* first, the Island's own food production is doubled with the population and, second, exports are also doubled, so as to buy the shortfall of food and other things that the people must have from overseas. We must *produce* more and we must sell to the outside world those things that the world *wants* to buy.

So far, only the plantation crops come into that category in any large way. On the basis of the plantation crops, the standard of living in Ceylon is twice as high as it is in India and still higher than in many countries in the area. Naturally, we should diversify the economy and get away from this dependence on a few products. But tea now provides two-thirds of Ceylon's foreign exchange. The proportion is tending to increase. We *must* produce more tea and we *must* double our export of tea in the next 20 years.

Can we do it? Scientifically speaking, I am convinced that we could do it. Yields are still being raised by improvements in cultural methods; and we are about

to discuss further new ways of raising yields. And under the shelter of those improvements we can uproot old tea and plant new, without annual yields ever falling. Once the first new tea comes into full bearing, if we use half of the increased yield to cover the loss of uprooting more old tea, in less than 30 years, the Island's production could be doubled by replanting *alone*. I am convinced that there is no scientific obstacle to that. What other obstacles are there? Why has replanting begun on only 3,000 acres, of the 30,000 acres planned?

I do not know the answer to this and it would be worth investigating. But I believe the answer in simple—lack of capital, lack of investment. The gambler says—if you don't speculate, you can't accumulate. The economist says—if you don't invest, you can't grow. If one includes capital used in replacements as well as capital for new developments, the annual investment per head in the West approaches the whole income per head in Ceylon. Unless there is a complete change in the rate of investment in Ceylon, we shall fall further and further behind in our standard of living.

Where is this capital to come from? Where the standard of living is already low, as in Ceylon, can you lower it still further, to gain local investment? In India, to some extent that is being done and the people feel that the lowering is worth while because it is temporary; and at the same time, capital is pouring into the country in gifts, loans, and enterprise money. How much new money is coming into Ceylon? Where is capital to come from?

One more point about capital. According to an article in the Ceylon Economist in 1958, the capital value of the tea industry in Ceylon is about Rs. 400 millions, in round figures. That is an artificially low value, because of the threat of take-over, and the weight of taxation. The replacement value is about 10 times as high and, to open new estates, here or elsewhere in the world, it would cost about Rs. 8,000 per acre. New estates are being opened in other parts of the world, but only Government can do so in Ceylon. The reason is that, of the amount that would be profit, according to Nicholas Kaldor, Government takes 85% in taxation of various kinds. That is to say, both the incentive to expand and the ploughed-back profit with which to expand, are taken away in taxation. But the country must have the tax revenue. How do we get out of this difficulty?

And now let us get down to cases. Our energies must be directed to the places where they can do most good. How is this matter of capital investment relevant to our work?

First of all in regard to replanting, the subsidy is intended to pay about half the cost of the actual work. In an exceptionally efficient low-country estate, I believe it may do that and more. But it does not pretend to cover the loss of yield—and of income—during rehabilitation and early growth. Nevertheless some estates find it worth while to make the investment concealed behind this loss of income. But what next? Already, some estates have raised their yields so high that factory capacity is seriously strained. If leaf production is to be doubled in 20 years, surely factory capacity will have to be doubled too? Now a present-day factory costs between Rs. 1,000/- and Rs. 1,500/- per acre that it serves, so that the investment required for 500,000 acres over 20 years would average at least Rs. 25 millions *per annum*. To me, this seems to be out of the question. Therefore we have to try to discover how factory capacity can be doubled more cheaply. At the moment, we are therefore emphasizing cheaper ways of withering, namely trough withering and drum withering on two shifts a day, instead of single-shift tat withering. That is not the end, but that is what we are looking at now. But remember, two shifts a day will wear out the driers and the rollers twice as fast. Capital still has to be found for any expansion.

The question naturally arises in all our minds, can we sell so much tea? Can we sell it at a profitable price? Remember that some other countries are increasing their production too. True, Indonesia is not, but the African countries combined are now passing Indonesia; at their recent rate of increase, they are doubling production every 7 years. India is selling to a rapidly increasing internal market, but India's production is rising at more pounds per annum than Ceylon's is. The rate of increase required, to double in 20 years, is 3.65% per annum compound interest; at present levels, this is about 15 million pounds increase per annum. Actual performance has so far exceeded the 10-year plan; but that plan is only two-thirds of what is needed. And can we *sell* so much more tea?

If we look at market trends, we could *not* sell twice as much conventional black tea in 1980 as we do today. Already, prices are not what they ought to be. In the last ten years, there has been a considerable fall in the value of money in the world. Cost of production has risen. Tea prices have fluctuated but I am not satisfied that they are tending upwards as much. In fact, apart altogether from a still greater increase of production, we *already* may fear over-production, especially if China intrudes into the market in a big way. The only way to sell so much *more* tea is to open new markets, best of all, new markets for a new product that the others haven't got. Our opportunity exists with Instant Tea, soluble powder tea, made in Ceylon, direct from green leaf.

We can today produce on a laboratory scale at St Coombs, a soluble powder tea that is recognisable not only as tea but has some of the characteristic taste of a Dimbula. In fact it is too strong and should be reduced by mixing with tea that has less taste. In this modern age, I believe that there is no real difficulty in converting this laboratory process to a factory scale. Supposing that this can be done, where should we be? I believe that the North American market alone could take the equivalent of 400 million pounds of black tea, made into Instant Tea, provided the quality and price were right. Perhaps that is where the main capital investment should go, into the product of the future, not the conventional product of the past.

Can we do better than the best now on the North American market? I think we can. There is a risk, of course, and the question is, who is going to take the risk?

We know that private exterprise can do this sort of thing, though naturally it sometimes fails. If the product is too expensive, if it has some little defect, or if it is not made to appear more attractive than its competitors, it *will* fail. We do not yet know if State enterprise can enter into this kind of market, in free competition, whether it can overcome consumer resistance and satisfy consumer preference.

That is to say, I believe that we can produce the leaf and that we can sell it, largely as Instant Tea. We are very glad to learn of the Hon'ble Minister's interest, of his promise of a pump-primer of Rs. 1 to 1½ millions, and of his desire to induce enterprise capital to build up what may become a Rs. 1,000 millions manufacturing industry.

One final word. When we look back at the industry and the T.R.I. over the past 25 years, we can see enormous rises in yields of tea and big contributions made to them by the T.R.I.—manuring, pruning, blister-blight control, vegetative propagation and many other matters, large and small. When in another 20, 30 and 40 years' time, *others*—and perhaps the younger men here too—look back at *our* work, I hope they, too, will find much to admire and to praise. We shall do our best to achieve that.

ORGANIC MATTER IN CEYLON TEA SOILS

J. A. H. Tolhurst

You will see from the papers to be presented this morning that discussions about organic matter are to be taken up from different aspects, and you may wonder if the phrase "organic matter" refers to one substance or to several. It does, in fact, refer to a series of products. When plant or animal material dies, whether it is above or below the soil surface, it immediately begins to decompose and the microbes active in this work are capable of transforming the raw organic matter into chemical compounds bearing little obvious relation to the original material. These compounds are often referred to as "humus", but I prefer to retain the term "organic matter" asking you to bear in mind that this paper deals with well-decomposed organic matter which has been incorporated into the very structure of the soil.

This organic matter plays an essential part in the life of the soil but, although fairly stable, it is not entirely free from still further decomposition by microbes. It is possible for it to be transformed to mineral products which do not have the same value in the soil. Bringing a virgin soil into agricultural use tends to destroy much of its original organic matter, and if we can measure the extent of this loss we can evaluate the effect of past cultivation and can try to predict what may happen in the future. Therefore, when I undertook a broad survey of Ceylon tea soils, I paid particular attention to the relation between the organic matter in those soils and in the forest from which most of the tea areas had come. It was far from easy to find undisturbed forest soils in some of the main concentrations of tea, but the analyses which I shall be quoting were done on soils which I believe are representative of the virgin forest in all the regions which concern us.

Let us look at Figure 1 showing the level of organic carbon in the top six-inch layer of forest soil. I will say more about the analytical method in a moment, but here is the percentage of organic carbon plotted against elevation of the site. It is clear enough that the organic carbon, which excludes roots as far as possible, increases steadily with a rise in elevation. The increase is not quite uniform, and there is often a wide variation between soils at similar elevations.

Now let us turn to Figure 2 for the tea soils, plotted from 200 samples, and compare it with the 60 forest samples plotted in Figure 1, each of which has a complementary point in Figure 2. Two features are prominent. There is less variation in organic carbon at most elevations and there is a slight but definite fall in the curve, from sea level to about 2,500 feet, before the organic carbon begins to increase rapidly with the rise in elevation. In the 2,500 foot region there is the least variation of all between the samples.

The "organic carbon" to which I have been referring was actually only the more readily analysable portion of the carbon in those samples. Some of the carbon in the organic matter was resistant and we took a representative selection of the soils for the tedious analysis of the *total* organic carbon. In addition, we analysed all the soils for total nitrogen, an essential constituent of organic matter. Finally, each of the top soils illustrated had a corresponding sample from six to twelve inches depth and some samplings were continued in regular layers to depths

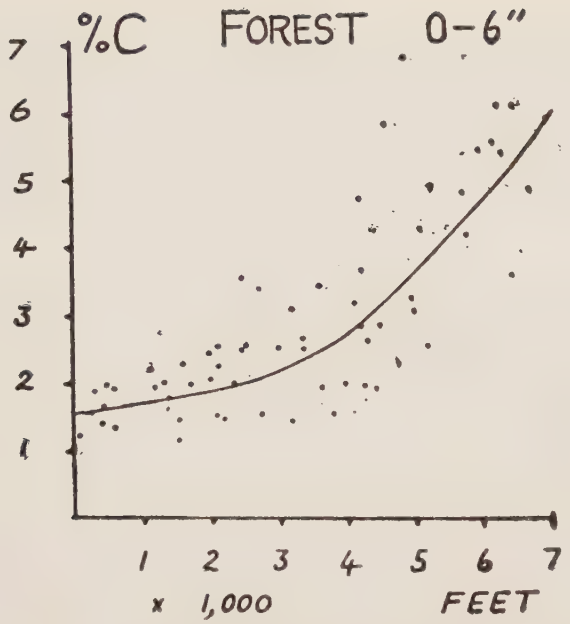

Fig. 1. The relation between organic carbon (Walkley and Black) and elevation in forest soils; 0-6".

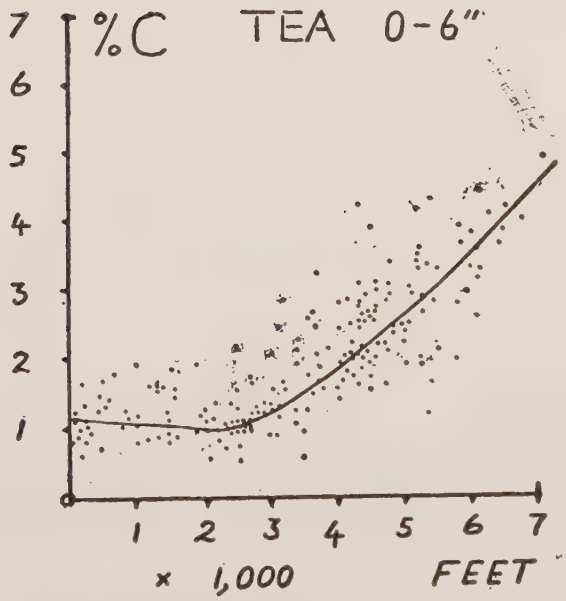

Fig. 2. The relation between organic carbon (Walkley and Black) and elevation in tea soils; 0-6".

of 3 to 7 feet. I do not intend to illustrate all these analyses, but I mention them to show you that we have checked and cross-checked before I could say that the analyses do in fact show that tea soils around 2,500 feet elevation have suffered more severely than others by a loss of organic matter resulting from their cultivation under tea, possibly following other crops. The tough, residual, organic matter analyses also reflect this feature, but a greater effect is shown by the softer fraction of the organic matter. The simplified graph in Figure 3 shows the relation between tea soils and forest soils in this respect.

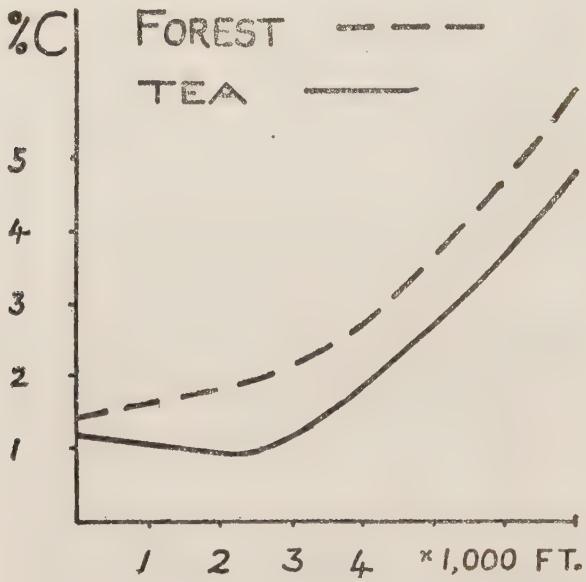

Fig 3. Comparison between the organic carbon in forest and tea soils; 0-6".

The obvious question arising is: "Why do tea soils at 2,500 feet suffer in this way?". The soils in question are as widely scattered as they could be in the tea areas, and include regions as different as Deniyaya and Hunnasgiriya, Ginigathena and Badulla. The past history of tea plantations is not always easy to obtain, but I have no reason to believe that these widely separated regions underwent more intensive cultivation than some others, either before or after tea was planted. The graphs show that the effects of the many variables in tea plantations, pruning cycles, shade, slope, aspect, etc., were decidedly subordinate to the influence of elevation. From visual and from analytical evidence I am not led to suspect that erosion of the top soil was so much more severe in these regions than in many others. A survey of some of the more fundamental chemical properties of the same soils has shown that they are remarkably uniform, and we can hardly look to the mineral composition of the soil to explain the pattern of the organic matter distribution. We do not have sufficient evidence to be able to answer this particular question, and indeed at this stage we can more profitably discuss the practical implications of a loss of organic matter, at all elevations.

In other contexts, I and my colleagues attach great importance to raw and partially decomposed plant material on or in the soil. What importance has the virtually invisible organic matter that is incorporated in the soil structure? It is true that it contains some plant foods, which it may release as it is decomposed, but

undecomposed it has the properties of cementing the soil particles into fertile crumbs, of maintaining a more uniform moisture status, and above all of holding manurial nutrients in such a way that they are less readily washed out by rain but are still available to plant roots. Some soils, in Ceylon and elsewhere, contain clay minerals which are also very efficient in holding nutrients. Unfortunately none of the tea soils which I have had examined contained any minerals of this type. Our clay mineral is of a highly degenerate and rather inactive nature, and the only component in the tea soils which we could hope to alter, in order to increase the efficiency of manuring, is the organic matter. Thus we have arrived at a highly practical point. We are starting more and more field experiments to find the most efficient way of using inorganic manure, and the interpretation of those trials will depend largely on a knowledge of the influence of the organic matter at each experimental site. The translation of the results into practical advice will in turn be influenced by the soil organic matter in each region. The extent of the influence of organic matter on manurial efficiency will not be known until much more work has been done, and for this reason I have avoided saying whether the analyses shown in Fig. 2 reflect enough organic matter or too little at certain elevations.

I have, and I think justifiably, assumed that the marked fall in organic matter over the last 60 or 80 years in the middle ranges of elevation is bad and must be checked. Perhaps recent changes in agricultural practices have already started a slow build-up of organic matter again. Only repeated surveys could answer that. The very wide variations in the region around 3,000 to 3,500 feet may be an indication that the restoration has already begun, probably under the influence of a more complete cover of the soil by the tea, and, not to be forgotten, with the assistance of vigorous root systems.

That, then, is the basic picture of the organic matter status of our tea soils in the late 1950's. I have outlined very briefly one of my reasons for treating this incorporated organic matter with respect, and one which is especially pertinent in view of our present increasing use of fertilisers. That aspect is not an isolated one, of course, but is part of the over-all scheme of work which we are all doing, namely striving to increase the vigour of the cover of tea.

Question No. 13.—Mr T. M. Fernando, Enselwatte Group, Deniyaya.

Will the application of high doses of nitrogen, using ammonium sulphate as the basis of nitrogen, create a deficiency of potash, magnesium and calcium in the tea bush? If the answer to the question is in the affirmative, what type of nitrogenous manure will the T.R.I. recommend?

Question No. 62.—Superintendent, New Peacock Group, Pussellawa.

(*a*) In view of the very high yields obtained from new and re-planted tea, manure dosages have been correspondingly increased at the recommended ratio of 8 to 10 lb nitrogen to every 100 lb of made tea. Is not the T.R.I. of the opinion that adverse factors are liable to emerge at high dosages? What upper limit of nitrogen does the T.R.I. recommend, so as to be fairly certain that the excessive dosages will not be harmful and also pay for itself in relation to crop?

(*b*) Is the T.R.I. of the opinion that a totally inorganic manure can safely be used without generous quantities of compost or some form of mulch?

Mr Tolhurst: I do think that the continued use of sulphate of ammonia at high levels will cause trouble, and I do think that in fact some instances of trouble have already been seen. The reason I say this is that on two of our manurial experiments—one in the low country, and one in the driest part of Uva—in spite of what we consider high dressings of potash, the tea is nevertheless showing definite symptoms of potash deficiency. I must add that a third experiment, also in the low country, has as yet shown no potash deficiency. I have also found, within recent months, potash deficiency symptoms on some of the highest-yielding estates in Ceylon.

Now, why is this deficiency appearing on tea which appears to be receiving plenty of potash? The main reason, I think, is a very complex nutritional one. All the tea referred to has been highly manured with sulphate of ammonia, which has the effect of releasing manganese reserves from the soil. (Please do not confuse manganese with magnesium). From quite a lot of leaf analyses it does seem that tea can accumulate too much manganese in its foliage. On St Coombs I have, simply by manuring bushes with manganese sulphate, induced them to show potash deficiency symtoms. There may, then, be an indirect competition between sulphate of ammonia and potash in the soil, as well as a direct competition.

Quite a lot of tea in Ceylon, particularly high yielding tea, is being manured generously, to say the least of it. Ratios of 12 or even 15 lb. nitrogen per 100 lb. made tea are not uncommon. I strongly advise you to examine your yield records very carefully, as Dr Joachim has just suggested, to decide whether your tea really does need such generous manuring. I would remind you that the TRI still holds to an 8 lb. ratio as a maintenance level of manuring, with a 10 lb. ratio to allow for expansion of cropping capacity. Some of you have gone one better, but the deciding factor is, surely, whether or not the tea is capable of increasing its frame and its capacity to yield more highly. If so, be generous with manure at a 10 lb. ratio. If not, restrict your nitrogen until you find a maintenance ratio to suit your particular conditions.

Therefore I will not state any particular upper limit for nitrogen manuring, as I was asked to do, as there is no one answer to that query.

If you do restrict the nitrogen, I suggest you restrict phosphate as well, but leave the potash level as it was; or even increase the rate of potash per acre. The problem I have mentioned can not be solved simply by increasing the potash manuring if sulphate of ammonia continues to be used excessively. It is a nasty problem, but I can suggest that we shall be moving towards richer potash manures in the next few years, and I would encourage you to experiment with mixtures which are at least 50% higher in potash than our present recommendations. This is particularly necessary for low country, where T.521 is already commonly used, for the mid-country, and for the lower elevations in Uva.

If you do use more potash, do not forget the need to use magnesium. This is, of course, part of our standard manurial recommendations.

Looking further to the future, we may find a more attractive way of tackling this problem. Rather than reduce the level of nitrogen we may be able to alter the form of nitrogen and avoid much of the damage resulting from sulphate of ammonia itself. Animal meals might replace some of the sulphate of ammonia for high yielding tea, but they are expensive and the fact that they are organic is, in my opinion, not important. Urea could be an alternative source of nitrogen, being less damaging than sulphate of ammonia, but introducing problems of its

own. If urea is used, you must avoid applying the manure in the wettest months. But, better still, is the "compound granulated" type of manure, quite new to the Ceylon market and as yet unadvertised. This type of manure has NPK and calcium compounded in fixed proportions in granules the size of rice, and, as long as it does not pick up moisture too readily the granules would doubtless be easy to distribute in the field. In general they are more concentrated than the usual mixtures. From my point of view I think the main advantage may be that half of their nitrogen is in the nitrate form. Nitrate would not be expected to bring manganese into solution in the same way that ammonium does, and thus we could expect less damage from such manures.

Summing up, I can say that higher potash manuring is suggested for certain districts and for high yielding tea in general, with restriction of nitrogen to the lowest possible maintenance ratio. Do not forget magnesium. If you do use any of the new manures I would like to know your opinions of their behaviour in practice, because my experiments cannot answer such points. Given a sufficient market, we could no doubt persuade manufacturers to develop formulations to suit any of our requirements.

Mr Tolhurst: Answer to the question 62 (b): There is no reason to think that high levels of inorganic manure necessarily destroy organic matter in the soil. In fact, with good husbandry, the reverse has often been shown in other countries, and may be expected to hold good for tea in Ceylon.

Question No. 36—Anon.

Will the continued use of dolomite have an adverse affect on tea?

Is Epsom salts preferable to dolomite in curing or preventing magnesium deficiency?

Question No. 36(a)—Mr T. M. Fernando, Enselwatte Group, Deniyaya.

Will the ammonium in ammonium sulphate create magnesium deficiency in the same way that potassium does?

Question No. 37—Mr Williams, Glen Alpin (Uva)

Why does the T.R.I. recommend Epsom salts for young tea and dolomite for mature tea?

Mr Tolhurst: There seems to be quite a burst of interest in magnesium, and first of all I will answer the query—"will the ammonium in sulphate of ammonia create a magnesium deficiency in the same way that potassium does?"

Yes, it will, but probably not to the same extent. There is generally a competition between ammonium and magnesium ions around plant roots, but nitrate does not show this adverse effect. This can be borne in mind when thinking about the new types of manure which I mentioned earlier. I must emphasise, however, that the continued use of any form of NPK manure without magnesium would eventually run the tea into magnesium deficiency as soon as the soil reserves were exhausted.

In reply to the fear that continued use of dolomite might have an adverse effect on tea, I can say that as long as dolomite is used as we recommend, and with the NPK manuring which we do now or are likely to recommend, the answer is: No.

"Is Epsom salts preferable to dolomite in curing or preventing magnesium deficiency"? and a similar question—"why does the T.R.I. recommend Epsom salts for young tea and dolomite for mature tea?" First let me make it clear that, as given in the *Tea Quarterly*, we recommend kieserite, which contains 24% MgO and not epsom salts with only 17–18% MgO. Both sell at the same price per ton, and both are known by the broad term magnesium sulphate.

Our reason for recommending kieserite for young tea is that it is quite easily soluble, and as young tea is particularly susceptible to magnesium deficiency we want a source of magnesium which will dissolve and reach the small root systems quickly. For the same reason kieserite is preferable for a quick-acting soil dressing in cases of known magnesium deficiency either in young or in mature tea.

Dolomite is only slowly soluble, but for a long-term prophylactic manure for mature tea I think it is perfectly satisfactory. It is possible that in areas of high rainfall it may be superior to kieserite for this purpose, being resistant to washing out from the root zone.

Question No. 38—Mr W. J. Childerstone, Balangoda Group.
To fork or not to fork? That is the question!
Could Mr Tolhurst kindly elucidate?

Mr Tolhurst: One of my colleagues very aptly commented that my problem in answering this question is—to talk or not to talk. I will take the easy way out and be very brief.

I look upon forking as being an operation to help—I emphasise the word "help"–to keep the surface soil reasonably well aerated. When we eventually get really compact stands of tea with vigorous root systems and plenty of leaf-mulch, I think we shall be able to rely on the tea bush, together with the much disputed shade trees, to keep the soil in this desirable condition. These conditions are not yet universal and as a matter of prudence I do still recommend one deep forking per cycle, or at lower elevations, once every other cycle, after pruning. I know a tendency at the moment is to forget the fork altogether, but as a long-term practice I think it is dangerous to go to that extreme now.

I am afraid that some of the low-organic-matter soils, those which I pointed out in my paper, may be more troublesome in this respect, and perhaps for many years to come they may need very shallow forkings within the cycle, in addition to the deep forking. If you feel that the surface is packing to a smooth, hard, crust then you are in a position to decide when to break that crust. But do not be too vigorous. There is no point in stirring the soil about so much that you make a loose, dry, mulch of it. A few shallow cracks at intervals of a foot or two might be sufficient to allow plumps of rain to soak in without running off. Organic matter, both in and on the soil, is probably a better answer in these problem areas.

To summarise the problem of forking, I would say: If in doubt, don't.

CONTROL OF SHOT-HOLE BORER (*XYLEBORUS FORNICATUS* EICHH.): EXPERIMENTS IN PROGRESS

E. Judenko

Introduction

Research on the control of this beetle, by using the post-war insecticide dieldrin, was begun by Austin (1953, 1955, 1956), carried on by Baptist (1956, 1956a), and then by myself from 1957. It is not yet possible to make any recommendation arising from the work.

Small-scale experiments done in the past

In 1957-59, I did about twenty small-scale experiments on fifteen estates in the low country and in the mid-country (Judenko 1958, 1960). In these experiments, the lower woody parts of tea in plucking were sprayed at various heights from the ground up to 24 inches. These experiments showed that, *provided the wood was dry at the time of spraying*, good control was achieved at a minimum dosage of 4 pints of "Dieldrex Extra" in about 100 gals. of water per acre (*i.e.* 2,500 bushes), using Horto Saphire nozzles 0.55. So we are standardising at 6 pints or, since "Dieldrex Extra" contains 20% of actual dieldrin, 1½ lbs. of actual dieldrin per acre. If, however, the wood of the frames is *wet* at the time of spraying, five or ten times as much dieldrin still gives poorer or more variable results.

Experiments in progress

We had to do small-scale trials, in order to be able to do enough of them to determine the minimum dosage; but small plots have the serious disadvantage that immigration of insects over the short distance to the centre of the plot may be very rapid. That is to say, our results on Shot-hole Borer on small plots are likely to be *less good* than on whole fields; but, at the same time, there is likely to be an effect of size of plot on other insects, like Tea Tortrix and its parasite, *Macrocentrus*. Therefore, we had to begin work on large plots. The objects of the new series of large-scale spraying were:—

(*a*) to follow the change in infestation after spraying, by counting the actual insects at intervals; we want to know how far the infestation recovers and how far it is new and due to invasion; (*b*) to follow the new damage done by the beetles, by counting galleries in new wood; (*c*) to investigate the side-effect of dieldrin spraying on Tea Tortrix about which Mr Cranham will speak; and (*d*) to investigate the effect of the control on the yield of tea. In order to avoid the risk of contaminating tea in plucking, we are now spraying only freshly-pruned tea. In all experiments, tea was sprayed to a height of 12″ above the ground level. The pesticide dieldrin is not a very dangerous one, like arsenic or parathion, but neither is it a relatively harmless one like pyrethrum or copper fungicides. We must not get it into the made tea and neither must we endanger the men who spray. I have explained in the

Tea Quarterly (Judenko 1958, 1960) what precautions have been taken. The only addition to them is that the operators are now provided with Kalutara hats. They must, of course, wash carefully when finished, and any insecticide left over should NOT be poured into drains or streams, because it will kill the fish and contaminate the water for many miles.

I have two series of trials going on at present; first, in the Kandy area and second, in Uva and Balangoda.

Experiments carried out in the Kandy area

In the Kandy area, there are medium-scale trials at Hantane, Kirimetiya and Bandarapola. Here, we used high dosages of dieldrin, for we wanted to find the maximum effect on the yield of tea. After 7–9 months, even in unsprayed control plots, there were few beetles; this is not unexpected, because the big population tends to occur after about 18 months. The sprayed plots did, however, have fewer beetles in them.

The time that has passed has, however, been long enough to allow Tea Tortrix to show itself. There were three times as many Tortrix on the sprayed plots as on the controls at Hantane, but no outbreak of Tortrix developed. Since Mr Cranham has shown in trials by estates that outbreaks developed after 50% of dieldrin sprayings, this perhaps may merely mean that I have been lucky.

Because the time since spraying has been too short for Shot-hole Borer to become conspicuous, it would not be surprising if there were no effects on yields of tea yet. On Hantane, for example, in nearly 9 months after pruning and spraying, the sprayed plots have yielded 2% more than the unsprayed, which is insignificant.

On Bandarapola, in a smaller experiment, after 7 months there were hardly any beetles in the control or the sprayed area and the difference in the yield was somewhat larger, but still insignificant.

On Kirimetiya after 8 months, there were more Shot-hole Borer in the unsprayed control than at Hantane and Bandarapola; the sprayed area had given 13% more crop, but it is still too early to say if this is a fair figure. We expect differences to show by the middle or the end of 1961, but of course, that is what we are trying to discover—are there differences, and when do they occur?

Experiments begun at Uva and Balangoda

These experiments, begun on three estates in September and October, 1960, were done on larger plots—whole fields—so as to give more realistic results, especially regarding Tea Tortrix. The general design was to take a whole field of 30–40 acres, and divide it into four parts. For 7–8 plucking rounds before pruning, the yields for the four parts were weighed separately. After pruning, two opposite quarters were left as controls and the other two were sprayed with dieldrin. Each dieldrin plot was divided approximately into two halves, one of which was to be sprayed with DDT on the foliage to suppress Tortrix.

The following amounts of "Dieldrex Extra" per acre were used in these three experiments. At Queenstown and Demodera, the tea is old and the bush density

is about 2,500 per acre; about 7 pints in 93 gallons of water were used at Queenstown, and about 6½ pints in 103 gallons of water at Demodera. At Rye, where the tea is young and the bush density is 3,400 per acre, 6 pints of Dieldrex Extra were used in 71 gallons of water per acre.

It has not been possible to carry out the design in full, because of rain, but the experiments are proceeding. These trials are as yet at much too early a stage to tell us much.

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THE NATURAL BALANCE OF PESTS AND PARASITES ON CEYLON TEA, ESPECIALLY TEA TORTRIX AND *MACROCENTRUS*

J. E. Cranham

The evolutionary concept of "a struggle for existence" between organisms of the same species and of different species was introduced by Charles Darwin just over 100 years ago and is now commonly known to the layman. It carries with it the corollary idea of "the balance of nature"—that the numbers of any organism, plant or animal, are controlled by natural enemies and by other factors, *e.g.* as antelopes are controlled by lions and diseases. Perhaps less well-understood is the use of the term 'environment' when used in an ecological sense. When used in this sense, the term implies all of the factors in the surroundings of an organism that affect it directly or indirectly; these may be broadly grouped under four headings: (1) the quantity and quality of food, (2) climatic and other physical factors, (3) other organisms of the same species and of different species, including natural enemies and diseases, and (4) a suitable place in which to live. The study of the distribution and abundance of animals and plants as affected by their total environment is in essence the science of ecology (Greek: *oikos*-house; *logos*-study).

The object of this paper is to consider in a general way certain aspects of the cultivation of tea as they influence the numbers of insect pests and parasites, with special reference to the balance between Tea Tortrix (*Homona coffearia* Nietn.) and the parasite *Macrocentrus homonae* Nixon as affected by the use of the insecticide dieldrin to control Shot-hole Borer (*Xyleborus fornicatus* Eichh.). In order to explain the nature of this balance, I shall have to deal first with general considerations, and in so doing I hope to explain the background to some of our work.

To expand on the definition of the term 'environment' as it applies to any insect or mite pest feeding on tea, let us consider each heading in turn. Each broad category of environmental factors is diverse and complex in character, but I can only deal briefly with each here.

1. Food.—The tea plant, or some part of it, is food to this insect and the abundance or occurrence of the insect is affected by the quantity of suitable food available. Hence, the nutritional and physiological condition of the bush, as well as the genetically determined characters, are of immense importance, especially for the sucking insects and mites. An example of the effect of the genetical characters of the bush is that high-jat tea is more prone to Scarlet Mite (*Brevipalpus californicus* Banks) and low-jat tea more prone to Tea Red Spider (*Oligonychus coffeae* Neitn.). Again there are very great differences in the susceptibility of different clones to Yellow Mite (*Hemitarsonemus latus* Banks) (Cranham, 1960) and possibly to Shot-hole Borer (Judenko, 1960). The development of clones or varieties which are resistant to pests is a large subject which I shall not go further into here. Equally, the effect of the nutritional and physiological condition of the bush on the incidence of pests is very great; on various crops there is work showing the effect of major and minor

nutrients, of water balance, age of foliage, etc., on the development of pests. A few workers have gone so far as to say that a healthy crop, correctly nourished and cultivated, does not suffer appreciable damage from pests and diseases. This is an extreme view of the subject. It is true that plants with a balanced nutrition will often be attacked less or suffer less, and as our knowledge increases we may be able to avoid many pest and disease troubles by suitable adjustment of the manuring and cultivation. These are preventative measures which are inherently sounder than the use of chemical curatives. However, we have a long way to go towards this, but the condition of the plant is manifestly of great importance.

2. CLIMATE affects tea pests both directly, and indirectly through the effect on the tea bush. The chief climatic factors are temperature, moisture and rainfall, light and sunshine, and wind. By experiments it has been shown that each species of animal has very definite optimum conditions for maximum survival, activity, sometimes for reproductive rates, and population increase. Above and below the optimum there is a falling off in survival, activity, or rate of increase. Beyond certain points inactivity occurs, and beyond that death.

Many instances exist in Ceylon tea of the effect of physical conditions, particularly temperature, as controlled by elevation, on the occurrence of pests. Thus, Shot-hole Borer occurs mainly between 1,000′ and 4,000′ elevation, a distribution that is thought to be due to temperature; *Lygus viridanus* Motsch. (Miridae) is a high elevation pest, usually at 5,000′ to 6,000′ elevation; *Helopeltis theivora* Waterh. (Miridae) is a low-country pest. Thus, tea districts with different climatic conditions have characteristic pests, an effect that is mainly due to climate though not necessarily entirely due to it. Certain pests are present in all districts and at all elevations to some degree.

Seasonal changes in the weather affect the seasonal abundance of pests, and outbreaks of some of our pests appear to be more conditioned by the weather than by natural enemies, *e.g.* Scarlet Mite and Yellow Mite.

3. COMPETITION may occur in various ways between individuals of the same species, *e.g.* in respect of food, shelter or mating. As examples, in a dense nettle-grub outbreak there is not enough food for more than a small proportion to develop; the amount of suitable wood in which female Shot-hole Borers can make galleries and reproduce may be strictly limited, as it is for some time after pruning.

Most species have natural enemies which are important in restricting the numbers of the host species. In the control of insect pests, other (entomophagous) insects are of great importance but there are also predatory vertebrates, spiders and mites, parasitic nematodes, fungi, bacteria, and viruses as agents of natural control.

Apart from direct competition and control, the indirect ways in which animals and plants in an ecological community affect one another are many and diverse.

4. The ecologist's concept of A PLACE IN WHICH TO LIVE implies a 'niche', not taken up by some other species, which provides the right physical conditions and shelter, and fulfills the requirements for mating, reproduction and feeding. With tea pests, we have species that feed on the flush, on mature leaves, on the bark, on mature and new wood, or on the roots. Many of them have to find other suitable places at stages of the life-cycle when they are not feeding on some part of the tea plant. A tea field, although it consists of tea bushes throughout, and is more uniform than any wild habitat, provides diverse local situations of which some are more suitable than others in providing the requirements of each species of tea pest,

and of their parasites and predators. Hence these insects are distributed in an uneven and patchy way over a field or a larger area, sometimes very markedly so.

This consideration leads us to the problem of how insects find the niches in which they are best suited to live, which involves the question of migration and dispersal. This we shall later consider in more detail for Tea Tortrix, and the parasite *Macrocentrus homonae.*

Tea plantations as an environment for insect populations

Tea is a perennial tree crop grown intensively on a very large acreage and this fact in itself is highly important. A long-lived tree crop, unlike an annual crop, exists for long enough on the same ground to build up a balanced community of insects and other organisms. It creates relatively stable and undisturbed conditions year after year and provides an environment for insects which can be compared to that of a forest. In the case of tea, this environment is disturbed by the use of pesticides only a little or very locally, for they are much less used on tea than on many other crops (*e.g.* on most orchard fruits).

There are therefore many plant-feeding insects and mites, together with others parasitic and predatory upon them, and scavenging species, which are very widely distributed in tea in relatively small numbers, *i.e.* in numbers sufficiently low for the plant-feeding species not to be regarded as pests. A high proportion of the insect pests of tea have tea as the major host plant; indeed, in the intensive tea districts there is very little else in quantity but tea, except for shade trees and weeds. Many species are almost omnipresent on tea, at least within the areas of their geographic distribution. Those which quite commonly reach damaging levels, we regard as serious pests; others which only occasionally do so are minor or occasional pests. It is important to remember that there are also other plant-feeding species widely distributed in tea, some of which could become numerous and a pest if changes in their environment permitted them to increase.

In the event of an outbreak of a pest, the planter is often inclined to ask: "Where did they come from?" In most cases, the answer is that they were already there on the field, or close by, and changes in the environment have resulted in a large increase in numbers. It is usually a very difficult matter to find what these factors are. Many important factors which have been mentioned above are quite outside the control of the tea planter, *e.g.* climate, the genetical characters of the tea bush (at least on a short term basis), and the numbers of natural enemies. I should like now to consider various routine practices in tea cultivation and their effect on the numbers of insects present, and the balance of populations. I refer to pruning, plucking, manuring, weeding and the use of shade trees. These practices are under the control of the tea planter, or modification of them is, although we cannot necessarily tell you in each case how to modify them to minimise pests. My purpose here is to emphasise the thesis that they do affect insect pests.

Pruning represents to many tea insects a drastic local curtailment of the food supply followed by a marked alteration in microclimate, and then with the growth of young sappy shoots, a change in the food supply. This we might expect would result in an unbalance for different species, for not only the plant-feeding species will be affected; parasitic and predatory species will emigrate from the field or die if there is insufficient host material for them to live on. In fact, a number of pests are more common on tea recovering from pruning, *e.g.* Purple Mite, Yellow Mite, Tea Tortrix, *Lygus*, Thrips and Aphis (*Toxoptera aurantii* Boyer). How far this due to a marked change in food supply, and how far due to a change in the relative

numbers of pests and parasites, is open to question. The former is undoubtedly of importance with many pests, but the effect of pruning on the latter has been largely neglected. It is probably fortunate that pruning is a local operation in that a pruned field is usually adjacent to unpruned fields—the migration into the field of insects that may have been wiped out by pruning can more easily take place. Pruning of very large areas simultaneously might in itself have more drastic effects on insect populations, resulting in wider fluctuations from the norm and in pest outbreaks. On the other hand, certain pests are notably few on tea recovering from pruning, *e.g.* Scarlet Mite, which usually becomes abundant in the third and fourth years of a pruning cycle.

Now we might expect that the type of pruning practised (*i.e.* whether it is hard or light, clean or leaving foliage), the season of pruning, and the length of the pruning cycle could all affect directly the numbers of insects and mites after pruning, quite apart from the indirect effect on the condition of the bush. In fact, instances of all these are available. More Scarlet Mites survive the kind of pruning that leaves foliage, and they can then more rapidly develop to damaging numbers. Hard pruning leaves less Shot-hole Borer in the frames than light pruning, a fact whose importance needs further investigations. The season of pruning affects the incidence of Yellow Mite, and of Tea Tortrix (Tubbs, 1934). The length of the pruning cycle affects the numbers of Shot-hole Borer in the bush frames at the time of pruning; there are less after three years than after two years (Gadd, 1949).

Plucking is a routine measure which has an effect on insects that feed on the flush and young shoots, notably Yellow Mite, Thrips, Tortrix and *Lygus*. For Yellow Mite, two close rounds of hard plucking have been recommended as a control measure, but it is not very effective; if we could afford to go in for stripping (*i.e.* removing all growing points even below the table) we might really control Yellow Mite by this method, but this is not a sound practice. If we put bushes out of plucking, and allow shoots to grow up (as for obtaining V.P. material or for resting bushes) we will often notice a marked incidence of Yellow Mite and sometimes of Tortrix. When a Tortrix outbreak occurs, it may be considered that the best thing to do is to rest the bushes; this can be dangerous, for whilst extra foliage will benefit the bushes, the soft young shoots will promote more of an increase of Tortrix. Plucking is in fact a partial control measure, and quite a sound one, for we are removing mostly young caterpillars, which are unparasitized, whilst when we attempt to control by hand-collection of the larger larvae, we are inevitably collecting parasites as well. In the case of *Lygus* bug, which is also a pest of the flush, some of the eggs are laid too low down the shoot to be removed by hard plucking (Calnaido, 1959).

Artificial manuring can have marked effects on the incidence of pests. I have previously mentioned the idea that balanced nutrition of a crop minimises the incidence and damage caused by pests and diseases, but apart from the use of natural manure and compost, it is not easy to determine what is balanced manuring in this context. Generally in agriculture, high nitrogen ratios in the manure create a predisposition to disease and pests, and lack of available phosphate and potash induce a decline in resistance. The classic example for potash is due to Andrews (1923) and concerned tea in India; he showed that the manuring of tea so as to produce a high ratio of available potash to available phosphate in the soil greatly reduced infestation by *Helopeltis theivora* Waterh. With regard to Shot-hole Borer, Gadd (1943) found that increased nitrogeneous manuring increased the crop although it also increased the number of branch breakages resulting from borer galleries; this sort of effect might lead to an initial increase in revenue but a longer-term loss of 'capital' in the bushes, but this has not been conclusively proved.

There is evidence from tree-fruit crops, that high nitrogen levels in the foliage result in an increase in the numbers of Red Spider mites. (Breukel and Post, 1959; Garman and Kennedy, 1949). There has been no investigation of this on tea. However I think it would be indeed surprising if the greatly increased manuring on tea in the last ten years, resulting in the doubling of the crop on many up-country estates, has not had some effect on the incidence of certain pests. We have no proof that it has, but I strongly suspect that the numbers of both Shot-hole Borer and of mites, more particularly Yellow Mite, are higher than they were ten years ago and that the use of more artificial manure has a good deal to do with this. Apart from the effect of the major nutrients, there is work on other crops to indicate the effect of deficiencies and excesses of minor nutrients on the occurrence of pests, but there is as yet no work of this nature on tea.

I can quote only one instance of the effect of weeds on the activities of insect pests on tea, but it is a good example. *Lygus viridanus* is a localised pest at elevations of 5,000 ft. to 6,000 ft. particularly in fields close to jungle areas. The chief hosts are wild plants, and although it can occasionally do severe damage to tea it does not seem to be able to survive on tea alone. Serious attacks have so far often been associated with a cover crop of *Drymaria cordata* and other weeds, and clean weeding resulted in control.

With regard to shade trees, some species are additional hosts for some tea pests. Thus, *Grevillea* and *Albizzia molucanna* are host plants for Scarlet Mite and Tea Red Spider, and tend to increase re-infestation of the tea after pruning (Baptist and Ranaweera, 1955). *Albizzia moluccana* is a common host for Shot-hole Borer of tea (Judenko, 1960a) although the importance of this is not yet clear. Apart from being hosts for tea pests, the degree of shade provided by shade trees influences pests; for example, very poorly shaded fields are more prone to Red Spider Mite attacks, and the drastic removal and pollarding of shade following the introduction of Blister Blight (*Exobasidium vexans* Massee) in South India and Ceylon was one factor in an increase of Red Spider Mite.

Biological control of insects on tea

I use the term biological control here in the sense of natural balances already existing as well as in the sense of artificial introductions of parasites or predators by man for the purpose of controlling a pest. It is clear that we have on tea a natural balance of many pests, and potential pests, with their natural enemies, a condition largely undisturbed by the use of pesticides.

The only chemicals used widely and routinely are copper fungicides for the control of Blister Blight (*Exobasidium vexans* Massee); this use does not affect most insect pests appreciably, as far as we know. However, it is fair to comment that the use of copper was adopted urgently to control an epidemic disease; the possible side-effects were not known by experiment beforehand; and in the following years when successful control of the disease was obtained, the possible side-effects have not been fully investigated. One such possible effect, on the increase of mites, is at present under investigation.

Clearly, it is in the interests of the tea industry to avoid the use of pesticides wherever possible; when we use them to control serious pests, that use should be well-informed. In the case of Shot-hole Borer in the mid-country, we have a most serious pest, and attempts over many years to minimise its attacks by cultural means have met with very little success. If we can use insecticides in such a way as not to disturb the general balance on tea we are justified in doing so. So far, in the use

Figure 1. Egg-mass of Tea Tortrix, containing about 140 eggs. The egg-mass measures 0.4 inches on its longest axis.

Figure 2. Newly-hatched Tortrix larvae emerging from an egg-mass. Each larva is about one-sixteenth of an inch long.

Figure 3. Tortrix larvae of the final growth stage on a leaf; they are about one inch long.

Figure 4. Tea shoots with leaves rolled over and webbed together by Tortrix larvae to form 'nests', inside each of which one larva feeds and is protected.

Figure 5. Tortrix female moth (left) and male moth (right). A female adult *Macrocentrus* is shown below. The female moth is half an inch long.

Figure 6. A mass of *Macrocentrus* cocoons on a leaf. Each cocoon is about one-fifth of an inch long.

of dieldrin applied to the bush frames after pruning, the only important side-effect observed has been an increase in the numbers of the Tea Tortrix caterpillars through local destruction of the parasite *Macrocentrus homonae*. In a survey, carried out in early 1960, it was clear that dieldrin had caused an increase of Tea Tortrix to a damaging level on about half the number of fields on which it had been used. In a few instances, damage by Tortrix was very severe.

Tortrix was a most serious pest of tea until the late 1930's, more particularly in all up-country districts in the South-West monsoon zone, although it occurred to some extent in all districts. It is now something of a rarity to see Tortrix in any numbers and many planters do not know the insect. The life cycle of Tortrix is that of a typical moth. Egg masses are laid by the female moths on the upper surfaces of mature leaves (Figure 1). The tiny newly-hatched larvae (Figure 2) tend to move upwards to the growing points of the bush and begin feeding. From the second instar to the fifth (final) instar, they make nests by webbing two or more leaves together, or sometimes of one leaf rolled over so that the sides are spun together (Figure 4). The larvae, or caterpillars, are dark green in colour with a shiny black head and about one inch in length when full grown (Figure 3). They do not devour the leaves completely and even in the most severe attacks Tortrix does not completely defoliate a field as can the Fringed Nettle Grub (*Macroplectra nararia* Moore)—some very ragged foliage is left. Several nests are usually constructed by one larva in the course of its development, and the mature larva pupates inside the final nest. The adult moth emerges about ten days later. The adult female is a small pale-brown tortrix moth, bell-shaped in outline when at rest and about 12—13 mm. in length; the male is more grey in colour and about 8 mm. long (Figure 5). The egg lasts about 6-11 days, the larval stage five to six weeks, and the pupal period is about seven-ten days. Thus, one generation takes about seven to eight weeks up-country, although evidence suggests it is only five to six weeks or less at lower elevations.

Various entomologists were concerned with the control of Tortrix for more than thirty years, including Green, Jardine, Hutson, Light, and Redman King. King spent several years studying possibilities for biological control. The indigenous parasites of Tea Tortrix which occurred at this time were well known and studied; they were numerous but none provided an effective control. It was not until 1935 that various parasites of Tea Tortrix present in Java were imported from that country. Amongst these was *Macrocentrus homonae* which was released at St Coombs in 1935 and again in 1936. By February, 1937, it was clear that the parasite had established itself on about 50 acres at St Coombs and that about 50% of the Tortrix host material examined was parasitized. Subsequent examinations on neighbouring estates showed that the parasite was migrating quite fast. Only two further liberations were made—one at Maskeliya in October, 1937, and the other at Madulsima in August, 1938. By 1939 it was known that the parasite had established itself in Dimbula, Maskeliya, Pussellawa, Dolosbage, Punduloya, Kotmale, and in Morawak Korale in the same year. It is interesting to note the remarkable migration of the parasite to the last named district, as this district is widely separated from others by extensive areas of jungle and other crops. These facts speak highly of the powers of migration of *Macrocentrus*.

Since 1940, Tortrix has been a minor pest of tea, and it is generally kept at a very low population density by *Macrocentrus*. The percentage parasitism is normally well over 80%. It is important to stress that Tortrix is not wiped out by *Macrocentrus;* if this happened, *Macrocentrus* would itself be destroyed, for as far as we know, Tortrix is the only suitable host insect for this parasite in Ceylon. Tortrix and *Macrocentrus* have been present on every field that we have examined for this purpose, although usually in extremely low numbers. As with any balance between a host

insect and its parasite, the numbers of both are fluctuating reciprocally, *i.e.* peak numbers of Tortrix are coincident with a trough in the numbers of *Macrocentrus* and *vice versa*. Tortrix is generally more numerous from December to April; occasionally and locally a peak in Tortrix numbers is sufficient to cause local damage and to be called an outbreak; environmental factors, most likely climatic, have caused a temporary unbalance, but the balance is usually restored within a few weeks.

Macrocentrus homonae is a small Braconid parasite described by Nixon (1940) and the life history has been described by Gadd (1946). In brief, the adult female parasite (Figure 5), by means of her long ovipositor, lays a single egg in each young Tortrix caterpillar that she parasitizes. Development of the parasite inside the Tortrix caterpillar is polyembryonic, that is, the single egg gives rise by division to several *Macrocentrus* larvae, sometimes as many as 40. These larvae feed at first on the body fluids of the Tortrix host, finally emerging from the skin of the Tortrix caterpillar when the latter is mature, and turning back to consume the whole host body except for the head capsule and part of the cuticle. Each larva then spins a silken cocoon inside which it pupates; all the cocoons from a single host are matted together to form a mass of brown cigar-shaped cocoons (Figure 6). The duration of development is about ten days for the egg stage, two weeks for the larvae, and two weeks for the pupae. Adult females live for 6–38 days in captivity. The life cycle thus coincides well with the generations of Tea Tortrix.

The introduction of *Macrocentrus* therefore resulted in an extremely successful biological control of Tortrix which had been a serious pest of tea for over 25 years, reducing it to the status of a very minor pest. It is interesting to note that a distinguished worker in the field of biological control, D. C. Lloyd (1960), has recently emphasised that most instances of successful biological control have been achieved on perennial crops, rather than on annual crops. Lloyd quotes instances on coconuts, citrus, coffee and various deciduous fruits, forest and shade trees, sugar cane, and alfalfa. To quote Lloyd in this connection—"the effective environment of an organism has been defined as that containing everything of direct importance to the particular organism. It is probable that tree and other perennial crops provide better approximations to this environment than do field crops because of their fortunate combination of extension, continuity, and fixity". Lloyd goes on to say "Really effective natural enemies have been shown to disperse rapidly and have good host-searching capacities. These faculties involve many sense organs, and prevailing opinion is that the adult is attracted first to the type of environment or host area, and then to the host insect".

It will be clear from these arguments that tea as a perennial crop relatively undisturbed by the use of pesticides is a most suitable crop for the preservation of existing natural controls and for work on the introduction of parasites where likely material is available. It is also clear that the question of migration or dispersal of the host (pest) insect and of the parasite is fundamental to our understanding of biological control.

The effects of spraying dieldrin

From the survey of estate trials with dieldrin that was made in 1960, we know that dieldrin had caused an increase in Tortrix population to a damaging level on about half the number of fields on which it had been used; on the others it had not. When a Tortrix outbreak did occur, it was in nearly all instances apparent about two or three months after spraying. This observation is very significant. We may be able to avoid Tortrix outbreaks if we know the factors conducive to them, and the detailed sequence of events resulting in them. At present the picture is not

complete, but let us consider some of the facts we have. Data in support of these statements will be reported elsewhere.

1. Dieldrin is not an effective control for Tortrix and, even when used at the rate of 1.5 lb. in 70 gallons of water per acre and applied as a thorough foliage spray, it gave a very low percentage kill.

2. On the other hand, it proved highly lethal to *Macrocentrus*, even when applied only to the basal parts of bushes in plucking. When a Tortrix outbreak develops after spraying with dieldrin, we find that the percentage of Tortrix parasitised by *Macrocentrus* is very low or nil, and the percentage gradually increases until the parasite has regained control and brought the Tortrix down to low numbers. In the instances observed so far, this has taken between two and six months.

3. Within a large field, it takes longer for *Macrocentrus* to regain control at the centre of the field than at the edges. The 'time lag' will presumably depend on the migratory powers of *Macrocentrus* and on the persistent effects of dieldrin.

Hence, it could be that Tortrix outbreaks develop from (*a*) individuals that survive on the field after pruning and spraying, or (*b*) individuals migrating in from neighbouring fields, or, of course, (*c*) both sources. We noted earlier that Tortrix is almost omnipresent in small numbers. Further it is quite likely that it is attracted to 'young' fields after pruning by the presence of many succulent young shoots, though we do not know this. Insufficient is known about the flight habits of Tortrix to know if it could migrate at such a rate as to result in outbreaks within two or three months, which is the duration of only one or two generations of Tortrix.

We can surmise that certain factors will influence the numbers of Tortrix present on a field after pruning and the rate of increase of Tortrix, *e.g.*:

(1) The type of pruning employed—we would expect clean pruning virtually to destroy the local Tortrix population because of shortage of food, and hence the *Macrocentrus* population as well; pruning that leaves foliage (as is usual in the mid-country) should allow some Tortrix to survive.

(2) The season of pruning—if pruning and spraying are carried out when the numbers of Tortrix are naturally somewhat higher or are rising, an outbreak is more likely. Numbers are normally rising in the latter months of the year, highest in December to April and falling off with the onset of the S.W. monsoon. They may also be reduced by the N.E. monsoon, particularly in Uva. It has in fact been observed that certain outbreaks were cut short by the onset of the monsoons.

(3) The time of spraying after pruning—if we defer spraying until the new foliage is growing, we are generally more likely to induce a Tortrix outbreak, probably because the persistent effects to *Macrocentrus* of dieldrin on the foliage are more marked than when dieldrin is on the bark only. Reference should be made here to the work of Baptist (1956) who found that if dieldrin was sprayed within two or three weeks after pruning and not later, Tortrix outbreaks did not occur. More recently, however, outbreaks occurred on two estates where spraying was done within a few days of pruning. Pruning in these instances left foliage, so that Baptist's conclusions may still be correct for clean pruning. However, the type of pruning employed in mid-country is usually necessitated by the condition of the bushes.

It is now clear that the disturbance to the balance between Tortrix and *Macrocentrus* occurs because dieldrin does kill *Macrocentrus* and does not kill Tortrix. Thus,

it may be that (1) there are Tortrix present on the field at the time of spraying which survive, but the *Macrocentrus* are virtually destroyed, so that the Tortrix population increases to an outbreak level in about three months, afterwards being brought under control by *Macrocentrus* migrating into the field; or (2) Tortrix is not present on the field but can migrate into it after spraying and multiply, but immigrating *Macrocentrus* are killed until the residual effects of dieldrin have gone. Both of these circumstances might apply in different cases, or both may act together; we do not yet know, but it is important that we find out in order to determine the best timing for control measures for Tortrix.

The disturbance to the balance between Tortrix and *Macrocentrus* might be prevented by using a chemical for shot-hole-borer control that does not have much effect on the parasite. This is not thought to be an attribute of any general insecticide that might control Shot-hole Borer, although some might be effective but much less persistent than dieldrin. Alternatively, if it is the survival of Tortrix on the field that matters, we may be able to use a chemical for shot-hole-borer control which also gives a high kill of Tortrix, or we may continue to use dieldrin and add DDT to it to control Tortrix.

It has been found that DDT will give an effective control of Tortrix. A single spraying round of 6 pints of a 25% DDT emulsion formulation in 50-60 gallons of water per acre has given effective control; the cost of the insecticide is only 10-12 rupees. The problem of when we might best use DDT depends on whether outbreaks develop chiefly from Tortrix which survive on the field or from Tortrix which immigrate.

If the former applies, we might use the DDT with the dieldrin, but here we must remember that the type of spraying cover required for spraying DDT against Tortrix and for spraying dieldrin against Shot-hole Borer are different. DDT for Tortrix must be applied as a thorough foliage spray and the dieldrin for Shot-hole Borer must be applied to the bark of the bush frame. Where cut-across pruning is practised, we should be able to use the dieldrin and the DDT effectively together to cover the whole of the bush frame and the foliage left; this would cut out the cost of labour for an extra spraying round of DDT. If pre-pruning or lung pruning are employed, separate applications of dieldrin and DDT will be necessary.

If, on the other hand, it is immigrating Tortrix that matter most, the use of DDT before bud-break will be ineffective and we shall need a separate application to the young foliage at, say, about tipping time. In any event, at this time it should prove effective in preventing an outbreak whether it develops from Tortrix which have survived *or* those which have immigrated.

It may be thought that there is some objection to increasing the use of insecticides in this way, by using DDT to control a side-effect created by dieldrin. We are correct to ask if DDT may not itself create further side-effects such as an increase in mites. With regard to *Macrocentrus* in this instance, we have already destroyed them with dieldrin, and we do not aggravate this with DDT; we are in effect keeping the Tortrix down artificially only until the *Macrocentrus* can return to carry on its activities. Evidence suggests that one spraying round of DDT is sufficient to do this. So long as DDT does not produce unwanted side-effects, which have not so far been observed, we can safely use it. It will be better to use it at about tipping time to prevent an outbreak than at a later stage to cure one, for damage from Tortrix is usually widespread before it is noticed, and by that time *Macrocentrus* may be starting to work into the field.

So far we have considered the factors upsetting the pest-parasite balance. Thought must also be given to the restoration of the balance. Here we are concerned with the persistent effect of insecticides to *Macrocentrus* and the migratory powers of the parasite. These aspects will receive study; certainly it appears that about three months after spraying if not sooner, *Macrocentrus* can migrate into the field, and that from then on it depends on the rate of migration and the size of the area treated. Normally we treat single fields of a maximum of 40-50 acres in extent and on this scale if does not take *Macrocentrus* more than a matter of weeks to reach the centre of the field once it is active at the edges. Evidence of its great ability for dispersal was quoted earlier. Moreover, the capacity of the parasite to find the host, and its rate of increase (being polyembryonic) are excellent. There is some evidence from instances when outbreaks lasted six months, which is longer than most, that this was because of difficult conditions for the parasite, such as excessive drought (the adult parasite must drink water) or excessively wet weather. Experience from the few estates that are progessively spraying all fields with dieldrin as they become due for pruning, does not suggest that the re-establishment of the parasite under this type of programme will be more of a problem than on single fields. Artificial introduction of *Macrocentrus* cocoons to the centre of a large field, once it is apparent that the parasite can enter the edges of the field, may be useful and could be easily done by labourers trained for it.

It is sometimes asked if the Tea Research Institute can supply the parasite for liberation in fields with Tortrix outbreaks following dieldrin. There is no need for us to do this. In all instances so far, the parasite was available nearby, and moved into the field from tea or jungle boundaries as soon as the persistence of dieldrin permitted it. Introduction before this time would fail. Once it is apparent that the parasite can enter the edges of the field, it may be useful to liberate it in the middle, but it does not take long for it to get there of its own accord.

The use of DDT mentioned here is still experimental, but several large-scale field trials have shown that it is promising. Pending the completion of trial work, there is so far no reason to think that Tortrix outbreaks will be a serious bar to the use of dieldrin, or that we need fear any permanent damage whatever to *Macrocentrus*, that precious ally that costs us nothing to maintain.

But we are not leaving the matter there, and large-scale trials are being carried out under our supervision on twelve estates. These trials must be large-scale and in various districts in order to assess the matter fairly. We have to have more evidence that unwanted side-effects will not occur. The work involved is too great for us to do alone, so we have had to ask for your help. This has been most generously given, and we are very grateful to the Superintendents and companies concerned.

We are hopeful that by the end of this year we will be able to give you an effective method of shot-hole-borer control by which Tea Tortrix can be prevented from causing trouble as well.

Summary

A description is given of the meaning of the term 'environment' in relation to pests and their natural enemies in Ceylon tea. The effects of certain routine measures in tea cultivation—namely, pruning, plucking, manuring, weeding, and the use of shade trees—on the incidence of pests and parasites are discussed. The value of natural enemies of tea pests is stressed; the fact that tea is a perennial bush crop

largely undisturbed by the use of pesticides creates conditions that minimise the upset to natural balances between pests and parasites.

A brief resume is given of the successful introduction to Ceylon of the parasite *Macrocentrus homonae* Nixon in 1935–6 for the control of Tea Tortrix (*Homona coffearia* Nietn.), formerly a major pest, and since 1939 a minor pest of Ceylon tea due to the activities of *M. homonae*.

The effects of the experimental use of dieldrin sprays after pruning for the control of Shot-hole Borer (*Xyleborus fornicatus* Eichh.) are described; *Macrocentrus* is virtually eliminated temporarily from the area sprayed. The probable factors influencing Tortrix outbreaks after spraying dieldrin are discussed; these include the survival of Tortrix after pruning and dieldrin spraying, the relative migration rates of Tortrix and *Macrocentrus*, and the persistent effects of dieldrin.

A single spray of a DDT emulsion (2 lb. actual DDT per acre) has proved an effective control for Tortrix, and the optimum timing for this additional treatment is considered.

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Question No. 14.—Mr G. C. Du Pre Moore, Supdt., Deltotte Group, Galaha.

Clone TRI 2026 has been found very prone to shot-hole attack in my district (Galaha). What information is there on the susceptibility of this clone to Shot-hole Borer and the advisability of using this clone for replanting?

Director: Dr Judenko's work on clonal resistance is so far in a preliminary stage. I believe there was no clear-cut indication for clone TRI 2026, and much more experience is necessary in different districts. A clone may still yield well although badly attacked, (*e.g.* TRI 2024). There is a preliminary indication that TRI. 2023 may be resistant. In respect of clones and Shot-hole Borer at present, superintendents will have to rely a good deal on their own local experience. (Judenko, 1960).

Question No. 15.—Mr R. J. Barlow, Stonycliff Group, Kotagala.

Do Shot-hole Borer and Tortrix live in shade trees?

Dr Judenko: Yes, Shot-hole Borer affects *Albizzia moluccana* and in a lesser degree Dadap and *Gliricidia.* Secondly, I was able to find that Shot-hole Borer from *Albizzia moluccana* is able to infest tea.

Mr Cranham: Tortrix has quite a large host-plant range; certainly it can be found occasionally in *Albizzia* and Dadap in small numbers. There are quite a few wild plants and jungle trees that also harbour Tortrix, and consequently also harbour *Macrocentrus* so that you can expect, and we have found, that *Macrocentrus* can come from jungle boundaries, as well as from tea boundaries, in to the sprayed field.

Question No. 16.—Mr J. G. Riminton, Supdt., Forres Estate, Maskeliya.

Is there any evidence of Shot-hole Borer developing resistance to dieldrin?

Question No. 17.—Mr W. A. Aiyadurai, Supdt., Madulkelle Estate.

Is there a possibility of the beetles developing a resistance to the dieldrin subsequently?

Director: There is certainly no evidence so far. Induced resistance is a difficulty which most commonly occurs with fast-breeding insects and mites, *e.g.* house flies, mosquitoes and red spider mites. It has occurred with relatively few agricultural pests. If it does happen, we shall have to face it when it comes, but there is no reason to concern ourselves about it at this stage.

Question No. 18.—Dr T. Visser, T.R.I.

Would it be practical to leave strips of unsprayed tea in a sprayed area in order to sustain *Macrocentrus* population and to assist in their re-establishment in the sprayed tea?

Mr Cranham: This thought has occurred to us and at least one planter has done it. It is very doubtful if it would help to maintain *Macrocentrus* which is a very active insect and would move across the dieldrin-sprayed strips. It would

certainly reduce the duration of control of Shot-hole Borer because reinfestation of the sprayed strips from the unsprayed strips would be more rapid than when whole fields are treated.

Question No. 19.—Mr A. V. E. Felsinger, Uva Ketawella, Hali Ela.

Is *Macrocentrus* the only known parasite to attack Tortrix? Are there others which may be less affected by dieldrin?

Mr Cranham: There are many parasites of Tortrix. I think about twenty were recorded before the introduction of *Macrocentrus* in 1935–36. None of these, however, was a really effective parasite, and they have since been virtually squeezed out by *Macrocentrus*. Recently we have noticed that one of them, *Bethylus montanus*, has been present in dieldrin-sprayed areas before *Macrocentrus* could get back. It would seem to be, therefore, less affected by dieldrin, but it is not likely to help very much in controlling Tortrix—it may help a little.

Question No. 20.—Mr G. D. Austin, Houpe Bungalow, Houpe S.P.O.

Are any experiments being laid out anywhere to ascertain the loss of crop caused by Shot-hole Borer?

Dr Judenko: Experiments are being carried out as given in my paper—three replicated trials and three large-scale experiments with duplicate plots only.

Question No. 21.—Mr S. Ananda Rau, U.P.A.S.I.
Mr P. de Jong, Tata-Fison, India.

Is any work in progress to find alternative insecticides to dieldrin for shot-hole control: and also alternatives to DDT for Tortrix control, to find a dual control agent?

Director: Some other insecticides have been tried. For instance, Dr Judenko earlier gave some attention to chlordane but he found dieldrin much superior on an equal cost basis. The trial work involved is very considerable and we have at present to concentrate our available resources on the promise shown by dieldrin if we are to achieve results. This is not to say that in the future we may not be able to improve on the method worked out.

Question No. 22.—Anon

How long has dieldrin been known to be effective against Shot-hole Borer? Could Mr Newton of Sanquhar say anything on this?

Mr Newton: Control of Shot-hole Borer was carried out on Sanquhar by Dr Baptist in 1955. He did three experiments. Unfortunately in the beginning no plucking trials were started; so we got no results on actual yields until later. It wasn't until a year and a half after the actual spraying took place that I decided to do some plucking trials in fields running on to three years. The results were not very good. Yet I managed to get my V.A. and the Company to agree to further trials. I did 9,000 bushes and against that I counted a 9,000-bush control. Our sprayed area was so good in comparison to the control that accordingly we decided to spray the entire pruned area. I have records of the monthly results, especially

on young tea. Some of the healthy tea has responded very well indeed, other fields not so well; but I can only say that practically all the fields which have been sprayed have shown an increase in crop over their pruning cycles. Whether this is entirely due to Shot-hole Borer or more manure and better cultivation, it is hard to say; but recent counts taken by Mr Cranham of Shot-hole Borer in standard units of wood show that dieldrin spraying has had a very marked beneficial effect upon the destruction of the borer beetle. In one instance, another insecticide has been used; comparing results with dieldrin after 18 months, although the actual attacks are approximately the same, there are no live larvae or live beetles in the dieldrin-sprayed area, whereas in the areas sprayed with the other insecticide there are considerable numbers of live larvae and beetles. I have written an article for the *Tea Quarterly* and you will be able to read in that exactly what we have been doing.

Question No. 23.—Mr V. Ratnayake, Deniyaya.

Have you observed any effect on prevalence of mite or red spider by the spraying of dieldrin for Shot-hole Borer?

Question No. 24.—Mr A. Passingham, Galbode Estate, Ratnapura.

It may be of interest that under the experiments carried out by Dr Baptist and Mr Austin at Galbode Estate in 1955, spraying with DDT in the control of Tortrix, following dieldrin spraying, in all instances resulted in intense yellow-mite infestation with seriously retarded growth of the young foliage.

Mr Cranham: In reply to these two questions, we have not yet seen any convincing evidence that dieldrin or DDT spraying will generally increase mite numbers. This may be so, and we are watching our trials carefully to find out. It must be remembered that Yellow Mite is very common on fields recovering from pruning and there must exist a big difference in mite attack between a sprayed area and a comparable unsprayed area in order to indicate anything. This we have not so far seen at all for Yellow Mite, but there is one trial where there is more Red Spider mite on the sprayed area.

Question No. 25.—K. D. Seelanatha, Matale West.

Isn't the widespread application of dieldrin over a period of years likely to eliminate *Macrocentrus homonae* or reduce it greatly so that, as prior to its introduction from Java, Tea Tortrix will once again appear as a serious pest, more serious than the incidence of Shot-hole Borer at present? What work has been done to approach the problem from a biological angle? Is there a possibility of approaching it, judging from the sex life of the *Xyleborus fornicatus*, in the manner the problem of the Screw Worm was solved by irradiation?

Director: This has got six or seven questions in it actually, and the first point is that before *Macrocentrus* was introduced from Java it was not present in the island at all, and the second is, as Mr Cranham has pointed out, once it got going here it spread extraordinarily rapidly and over wide gaps; if all tea in Ceylon or in the shot-hole-borer country were pruned in the same week or in the same month, there might be a danger of serious interference with *Macrocentrus* if all that tea were sprayed with dieldrin. But in fact the situation is not at all like that. In a large part of the shot-hole-borer country, pruning cycles are 3 or 4 years, that is to say, in at least a third of your tea the *Macrocentrus* on it has had ample opportunity to

recover, and it can then invade the neighbouring fields which have recently been sprayed. I don't think there is the slightest danger of eliminating *Macrocentrus* by this dieldrin spraying. Nor do I think that it will seriously affect the population.

The second part of the question: first of all there might be a misconception about the name of this species—*fornicatus*. This was named by Eichhoff in Germany, nearly 100 years ago, from a specimen from Ceylon; the name *fornicatus* means arched or vaulted in this context. There are, however, many ways in which we might approach the problem of control, but the use of gamma-rays or X-rays—irradiation—to sterilise the males—a method used with Screw Worm—seems to be one of the least likely to succeed for Shot-hole Borer. This method proved practicable for the Screw Worm, but is probably applicable to only a very few pest problems.

Question No. 26.—Mr R. M. Winter, Manager, Pillagoda Valley Estate.

What are the views on pruning deeper into wood affected by borer until galleries are eradicated—does this control borer effectively?

Director: People have tried hard pruning, and various other things, but have abandoned those lines now. We have, in the low country, frequent pruning—18-month pruning cycle—which is a quite useful thing. We are trying to deal with the insect on its own merits, and to allow pruning of the bush in the way that is best for it.

Question No. 27.—T. Moreton, Lethenty Group, Hatton.

Referring to tea not attacked by Shot-hole Borer, can Tortrix be controlled by spraying 'Arkotine'. Also does a ground cover such as *Drymaria* harbour *Macrocentrus* and thereby prevent it from infiltrating into tea?

Mr Cranham: 'Arkotine' is a DDT emulsion and can therefore be used for Tortrix control in the way described. We know of no connection between weeds or cover crops and the activities of *Macrocentrus*.

Question No. 28.—Mr Ananda Rau, U.P.A.S.I.

Is there any explanation for the failure of dieldrin to control Tortrix, which is stated to be readily controlled by DDT, considering that both are chlorinated hydrocarbons?

Director: That is the sort of question that I think many people in other parts of the world are trying to answer, and our set-up is not an appropriate one to tackle that sort of question. There is a great deal of variation in the activity of different chlorinated hydrocarbon insecticides.

Question No. 30.—Mr Frank de Silva, Epalawa Estate, Kegalle.

China tea appears to be more resistant to Shot-hole Borer than the Assam jat. Would it not be possible to produce a hybrid of these two which would be fully resistant to this pest?

Director: Mr Cranham says that he has seen China jat badly attacked. That is to say, in his view, the first assumption is not correct. Secondly, there are in the Island enormous numbers of varied hybrids of China and Assam jats. We have tried to get planters to discover a single bush which is uninfested in an infested field and so far we have not got anywhere with it, and it is for that sort of reason that we are going on now with this insecticide work which does look as if it is very close to success. Any breeding programme is likely to be extremely protracted, and there is no guarantee of success. We may find individual seedlings which appear to be resistant and of course Dr Judenko is studying the existing clones. Preferably we want to choose our clones for yield, quality, vigour and all that sort of thing; and rather than reduce the value of these qualities by breeding into it Shot-hole Borer resistance, we feel that it is more profitable to get the best bushes we can for yield, and so on, and use our insecticide.

NURSERY MANAGEMENT

A. L. Elias

Introduction

Many of us are about to undertake the replacement of old and uneconomic tea with high-yielding, vegetatively-propagated material. Therefore, costs and information on nursery management and new clearings and details of the various aspects of uprooting, rehabilitation, and replanting may be useful. A great deal of the information has already been published in the *Tea Quarterly* (Visser & Kehl, 1958) and as a separate bulletin (Visser *et al*, 1959). In spite of this, many requests for information are received each week and it is therefore intended to cover as fully as possible details of each operation from the nursery stage until the replanted tea is finally in bearing.

Nursery—situation and extent

It is generally accepted that nursery organization is the most important operation, if final success is to be achieved in the field. It is therefore necessary to decide at the outset whether a large, permanent nursery, to last, say, 5–10 years, should be constructed in a central situation, not too distant from the area to be replanted, or whether a sufficiently large temporary nursery should be put up close to the area to be replanted each year, and abandoned or planted up after the necessary plants have been produced for each year's replanting.

A decision will depend on the availability of land for suitable sites to lay down a nursery. On some estates, ample space is readily available, whilst on others, space is very difficult to come by. But the economic aspect should be thoroughly investigated before a final decision is made.

A central permanent nursery of sound construction pays dividends. Soil can be brought in from outside for each year's plants and sufficient space for as many cuttings as are required each year will be all that is necessary. If this is not possible, perhaps subsidiary nurseries could be built to supply any shortfall.

Nurseries should be fenced round at the beginning, either with live fences (*Gliricidia* or dadap cuttings, closely planted) or with concrete posts and barbed wire, as considerable damage can be done by stray dogs, cattle and buffaloes, and theft is not unknown.

Nursery Conditions

A properly drained site is essential, as water-logging will have disastrous effects. The availability of water is also an important factor.

When these two requirements have been met, the soil should be tested (*a*) for pH and (*b*) for eelworm infestation. Soil samples should be taken from different parts of the site and submitted for testing. Messrs Colombo Commercial Co. Ltd., A Baur & Co. Ltd., or Fisons (Ceylon) Ltd., operate free services for testing soil. If the pH is between 4.5 and 5.0, then generally the soil can be considered suitable. A high pH can be corrected by applying Flowers of Sulphur at 1–3 ozs. per sq. yd., or $\frac{1}{3}$rd lb to 1 lb. per cubic yard of bulked soil. The sulphur should be thoroughly mixed with the soil which is then watered daily for 6 weeks before planting operations commence. The addition of peat at 1:1 also reduces a high pH and improves the condition of the soil at the same time. Organic manure should *not* be mixed in the soil before planting cuttings.

Fumigation of nurseries on up-country estates is considered to be absolutely necessary and is desirable for mid-country estates (Hutchinson, 1960). The method currently used involves injecting the fumigant into the prepared soil, using an injector gun. Two guns are available: (1) Macleans "Fumigun" obtainable from Maclean Company, 1536 Industrial Way, Belmont, California, which costs Rs. 100/- F.O.B., and (2) the Shell Co. of Ceylon Ltd. market a gun called the SHELL D-D injector gun (MK 111 A) which has to be calibrated. An instruction leaflet giving complete details is available, but further advice regarding the use of this gun can be had from the T.R.I. The cost of the gun is Rs. 100/-. Using either Shell D-D soil fumigant, Shell Nemagon or Fison's Nematox at a dosage rate of between 25 and 30 Imperial gallons per acre, the soil must be injected to a depth of 6″ every foot in each direction. This injector holds about 2 quarts of liquid and gives a standard injection of $2\frac{1}{2}$ c.c. which is effective to a depth of 18″. The cost of Shell D-D soil fumigant is Rs. 13/50 per Imperial gallon and Nemagon costs Rs. 100/- per Imperial gallon.

The operation should be carried out when the soil is moist and neither too wet nor too dry. Immediately following fumigation, the area should be heavily thatched with Guatemala grass, Mana grass, jute hessian, or empty manure sacks which have been washed. This is done to minimise loss of the fumigant which, being heavier than air, escapes by vaporisation because the soil is warm. The covering should be left on until three days before the land is thoroughly cultivated, and should then be removed to allow all the fumigant to escape from the soil. Planting operations can commence after three weeks during warm dry weather and after five weeks during wet weather. All soil used for basketing, regardless of its source, should be fumigated and this should be done under cover, preferably in a shed, to prevent the soil from drying out or getting too moist. It should be emphasized that sub-soil, jungle soil, or soil from Guatemala grass areas should be fumigated, since it is possible that soil brought into nurseries from areas which have not been weeded, or from areas which receive drainage water from infected areas above, may be heavily infested.

Note:—The use of Shell D-D or Fison's Nematox is recommended for up-country areas only. Nemagon should not be used at high elevations but is suitable for use in the low country.

Preparation of Beds and Cuttings

It is necessary to decide well in advance what cuttings are to be planted in the nursery. If mother bushes are available on the estate, a bud and two leaves should be removed from each shoot two to three weeks before the shoots are due to be taken for cuttings, in order to induce axillary bud development. A cutting with the axillary bud starting to develop gives better results than one with a dormnat

bud. If possible, cuttings should not be taken during the latter part of the dry season or during a drought. If a particular clone is known to be a poor rooter, four to six applications of urea sprayed at weekly intervals (at an application rate of 1 lb. per 10 gallons of water, 6 lb. per acre), commencing immediately after the removal of the tips, will further assist axillary bud development. Spraying of urea must be done during reasonably dry weather.

Note:—Urea is an organic substance containing 46% nitrogen and is 2.2 times as concentrated a source of nitrogen as sulphate of ammonia. Being a neutral nitrogenous fertiliser both chemically and physiologically, it does not affect soil pH adversely and can be used as a foliar nutrient on mother bushes or for spraying plants in the nursery or in the new clearing.

When preparing nursery beds, it is recommended that beds be 3 ft. wide and 6–9 inches high. The earth should be loosened to a depth of 12–15 inches. All stones, roots and gravel must be removed to a depth of one foot and hard lumps of earth should be broken down or discarded. A good-textured soil is essential. It is generally desirable to use jungle soil as a top dressing. If tea fluff is used in any soil mixture, it should be added in the proportion of 1 part to 5 parts soil. The mixture should be allowed to decompose for about 3 weeks before use, being frequently turned over during this period and lightly watered. Imported peat moss, if available, can be mixed with the existing nursery soil and gives excellent results. The cost per bale of peat moss is approximately Rs. 40/-. Sub-soil (from 3 to 6 ft. below the soil level) has been found to be free from harmful organisms and, mixed with tea fluff 5: 1, makes an excellent top dressing. The mixture should be watered and turned over every week for six weeks before use.

Planting Cuttings

At St Coombs several methods have been adopted. The commonest methods are:

(*a*) cuttings direct in beds with sub-soil and tea fluff 4–6″ top layer;

(*b*) cuttings direct in baskets with soil and tea fluff;

(*c*) cuttings direct in polythene bags with soil and tea fluff;

(*d*) cuttings direct in beds with nursery soil and peat moss 4–6″ top layer.

Satisfactory results have been obtained from all four methods but costs vary considerably and the space factor has to be given serious consideration. These aspects will be dealt with later.

As soon as the beds are ready to receive cuttings, a light watering should be done. Single-node cuttings, consisting of one full leaf and an internode, should be taken, in the shade, with a very sharp knife (a bud-grafting knife is suitable) and immediately placed in a large galvanized bucket filled with water to prevent drying out. The lower end of the stem should be immersed in water immediately after cutting. Shoots should be divided into cuttings, the tender portion and the woody base of each shoot being discarded. Planting should commence as quickly as possible after cuttings have been taken.

Half-leaf cuttings, *i.e.* the top half of the nodal leaf cut off, allows for a greater number of cuttings to be planted. They root equally well, but subsequent growth is retarded by comparison with cuttings planted with the leaf intact.

The planting operation is an important one. The earth on the bed should be stamped down firmly with a plank immediately before planting. Light watering should precede planting and stamping down should be done before each section of approximately two to three feet is planted. Each cutting is held between the thumb and forefinger and inserted gently into the soil up to the axil of the leaf. Planting cuttings with ragged ends and bruised cuts should be avoided. The earth round each cutting must then be pressed down firmly to avoid leaving air pockets. Cuttings should be placed at an angle so that the leaves lie flat on the surface of the soil, in rows, and the apex of each leaf pointing into the direction of the wind. Further light watering should follow immediately after planting. It should be noted that planting in heavy rain should be avoided. In the case of baskets and polythene bags, the amount of earth required from outside is quite considerable. The mixture of sub-soil and tea fluff 5:1 is recommended. The polythene cylinder in various sizes can be purchased locally by the roll and cut into the required lengths with a sharp knife or blade. The most useful size for nurseries is 6″ wide in the roll; when this is opened out into a cylinder, its diameter is nearly 4″ (actually 3.82″). The bottom of the bag can be stapled or spot-welded with a candle flame in the centre to simplify filling and early handling. Two holes are punched on either side of the bag, about midway down. This allows for seepage of excess water and allows air to pass through the bag. It has been noticed that moss forms rapidly inside the polythene cylinder but this has no detrimental effect on the eventual success of cuttings planted in this manner. The bags are filled with earth and packed as tight as possible without causing damage to the bag. Bags are placed next to each other and held together by supports of either planks, round timber, or cement bricks.

Either one or two cuttings are planted in each bag. The dry weight of earth per small polythene bag, 4″ in diameter and 9″ long, is approximately 3 lb. The larger ones from a 10″ roll are 6.35″ in diameter; at 9″ long, they hold about 9 lb of dry soil. These polythene cylinders will last for at least 14–15 months, perhaps longer, and they are unlikely to disintegrate in the way that baskets do. Various types of baskets can also be used but it is doubtful whether any bamboo basket will last longer than 8–9 months without disintegrating. The dry weight of earth per basket of 6″ diameter at the top and 9″ high is also 3–3¼ lb.

Shade Requirements and Watering

It must be remembered that shading and watering are interdependent operations. If shade is dense, less watering is required but with less shade more water is needed. But over-watering and over-shading are equally harmful and will result in rotting, poor rooting, and decreased growth. The ideal should be to have medium shade, sufficient for the very light filtration of sunlight. In order to avoid wilting and sun-scorch immediately after planting, watering should be done in small quantities and often, so that the atmosphere under the shade is reasonably humid and cool. Various methods of shading can be adopted but the cheapest is bracken fern which is inserted in clusters between the cuttings and along the sides of the beds. This method depends entirely on the availability of fern. The taller the fern the better. Variations which have proved successful are as follows:—

(*a*) using the taller fern in the middle of the bed and the shorter fern on the sides, tapering gradually from the middle towards the sides;

(*b*) using fern of one height, at least 2 ft tall;

(*c*) building a frame with stout poles round the bed with small cross poles sufficiently close on top to insert short fern over the top of the frame. Fern has to be inserted along the sides of the bed as well.

Other methods are:

(*d*) bamboo slats;

(*e*) iron or bamboo hoops with open-weaved coir matting, the size of mesh to range from $\frac{1}{8}''$ to $\frac{1}{2}''$. The width of mesh will depend on local climatic conditions.

Of the above methods the most efficient system though not the least expensive is (*e*) because it provides equal light conditions over the whole bed, makes nursery operations such as weeding and manuring easier, and can easily be taken off to replace dead cuttings in the first few weeks after planting. The matting can be used over and over again. During warm weather, the sides can be lifted for a short period in the morning to allow for increased air circulation after the cuttings have rooted. At this stage less watering and more light are required.

For large nurseries the purchase of a sprinkler may be worthy of consideration, since watering can then be easily controlled. Watering should not be done at all during rainy weather and, even at other times, only if the soil shows signs of becoming too dry. Watering should be done intelligently, *i.e.* to keep the soil moist, and not too dry or soaking wet. A water-logged soil is very bad.

Transplanting

The ideal to be achieved in the nursery should be a high percentage of cuttings successfully rooted, healthy vigorous plants 10–12″ high in 9–10 months, and a low cost of producing a plant. There are three methods of transplanting generally practised:

(*a*) cuttings in callousing beds are transplanted into baskets and finally transplanted into the field;

(*b*) cuttings are planted direct into baskets or polythene bags and these are transplanted into the field;

(*c*) cuttings are planted direct into beds and transplanted directly from the nursery into the field (bed plants).

The use of callousing or rooting beds is a thing of the past; it is unnecessary, and costs and nursery space are all-important. The use of baskets is expensive, but assuming that only small numbers of plants are handled each year, as in the case of multiplication plots and small clonal blocks, or if the plants are liable to be subjected to long periods of drought, or are planted in areas where the soil conditions are poor, then there is ample justification for the use of baskets. Direct planting in polythene cylinders, however, has so far given excellent results and costs are a good deal lower than when using baskets. These cylinders have many advantages over the basket, namely, disintegration is less, the soil is held together more compactly, moisture retention is greater and therefore watering is reduced from a daily to a bi-weekly operation, and manure is not leached out as easily.

When large areas are to be replanted, involving hundreds of thousands of plants, a realistic approach should be adopted. Bed plants have been grown with great success, but correct spacing initially in the nursery is essential. This brings us to the matter of nursery organization.

Nursery Organization (Land Requirements)

Three methods are postulated: A + B—rooting in beds, then transplanting into small polythene cylinders or baskets, which are later planted in the field; C—rooting direct into clipped polythene cylinders which are slit open when planting in the field; and D—rooting in beds followed by naked root (not balled) planting in the field. All beds should be 3 ft wide and paths are assumed to be 20 inches wide.

The distance between rows and the distance in the rows is generally 3″ × 3″ or 3″ × 4″ where rooting beds are concerned and 4″ × 4″ where direct bed plants are concerned. The cuttings are put at half of these distances from the edges of the bed and the numbers of cuttings per square yard are then as follows:—

(*a*) 3″ × 3″ = 144 cuttings
(*b*) 3″ × 4″ = 108 cuttings
(*c*) 4″ × 4″ = 81 cuttings

The distance between rows and the distance in the rows for baskets and polythene cylinders depends on the size of basket or polythene cylinder; some examples of the number per square yard are as follows:—

(*d*) small polythene cylinders 9″ long, 4″ diameter=90 bags per square yard.
(*e*) large polythene cylinders 10″ long, 6″ diameter=30 bags per square yard.
(*f*) baskets 7″ long, 5″ diameter (tapering)=about 60 baskets per square yard.

Therefore the bed space, without paths, required for one field acre, *i.e.* 6,000 cuttings or sufficient material to plant 5,000 on ONE acre is as follows:—

(*a*) Rooting beds 3″ × 3″	=	42	square yards per field acre
(*b*) Rooting beds 3″ × 4″	=	56	,, ,, ,, ,, ,,
(*c*) Direct bed plants 4″ × 4″	=	74	,, ,, ,, ,, ,,
(*d*) Small polythene cylinders	=	67	,, ,, ,, ,, ,,
(*e*) Large polythene cylinders	=	200	,, ,, ,, ,, ,,
(*f*) Baskets	=	100	,, ,, ,, ,, ,,
(*a*) + (*d*)	=	109	,, ,, ,, ,, ,,
(*b*) + (*d*)	=	123	,, ,, ,, ,, ,,
(*a*) + (*e*)	=	242	,, ,, ,, ,, ,,
(*b*) + (*e*)	=	256	,, ,, ,, ,, ,,
(*a*) + (*f*)	=	142	,, ,, ,, ,, ,,
(*b*) + (*f*)	=	156	,, ,, ,, ,, ,,

From the above, it will be seen that where direct bed planting (*c*) is used, the bed space required in the nursery is comparatively small, and that direct planting into small polythene cylinders (*d*) does not entail a great deal of space when compared with the combination of rooting beds and small polythene cylinders (*a*) + (*d*), or of rooting beds and baskets (*a*) + (*f*).

Nursery Organization (Soil Requirements)

The volume of earth in cubic feet in relation to the depth of top soil layer *per square yard* of nursery bed and the total volume per square yard of polythene cylinders and baskets is as follows:—

(*a*) Rooting beds 2″ top layer	...	1.5 cu. ft.
(*b*) Rooting beds 4″ top layer	...	3.0 ,,
(*c*) Direct bed plants 6″ top layer	...	4.5 ,,
(*d*) Small polythene cylinders	...	5.3 ,,
(*e*) Large polythene cylinders	...	7.0 ,,
(*f*) Baskets	...	4.5 ,,

Therefore the volume of earth required for one field acre, *i.e.* 6,000 cuttings or sufficient material to plant 5,000 on one acre, is as follows:—

(*a*) Rooting beds 2″ top layer (3″ × 3″ × 2″)	...	62 cu. ft.
(*b*) Rooting beds 4″ top layer (3″ × 4″ × 4″)	...	167 ,,
(*c*) Direct bed plants 6″ top layer (4″ × 4″ × 6″)	...	333 ,,
(*d*) Small polythene cylinders	...	450 ,,
(*e*) Large polythene cylinders	...	1,500 ,,
(*f*) Baskets	...	450 ,,
(*a*) + (*d*)	...	512 ,,
(*b*) + (*d*)	...	617 ,,
(*a*) + (*e*)	...	1,562 ,,
(*b*) + (*e*)	...	1,667 ,,
(*a*) + (*f*)	...	512 ,,
(*b*) + (*f*)	...	617 ,,

The volume of earth required for direct bed planting (*c*) is the smallest and direct planting into either small polythene cylinders (*d*) or baskets (*f*) does not require much more. The combination of rooting beds and small polythene cylinders (*a*) + (*d*) or rooting beds and baskets (*a*) + (*f*) requires a little more but the very large amounts of soil are needed when large polythene cylinders are used. For easy working the following table is given:—

1 cu. ft. of sub-soil	=	74 lb.
1 cu. ft. of wet earth	=	101 lb.
1 cu. ft. of tea fluff	=	21 lb.
1 cu. ft. of tea fluff and sub-soil in proportion 1:5	=	60 lb.
24 cu. ft. of loose soil	=	2,240 lb.

Manuring

This important operation should commence 8–12 weeks after planting, *i.e.* after the cuttings have rooted. Commence with 6–8 applications of STARTER MIXTURE No. 1, applied once a fortnight at 4 ozs. per 10 gallons of water on approximately 10 sq. yds., followed by 2–4 ozs. of an organic such as STERAMEAL 'A' per sq. yd., once per month thereafter. Naturally, there are other organic and

inorganic fertilisers available on the market and any of these could be used. Manure should be scraped in with a small stick or iron prong and care should be taken not to manure too near the cuttings as this will scorch the leaves. Soluble manures such as T/175 can also be used at an application rate of 4 ozs. per 10 gallons of water on 10 sq. yds., applied once fortnightly. Constant stirring during application is necessary because the phosphate tends to settle at the bottom of the watering can. Diluted cattle urine or cattle manure in water has produced excellent results. It is most important that regular applications of manure be given. Often after the cuttings are planted and the shade put on, no further attention is given for several months; this is a common mistake which should be avoided. Gradual thinning out of shade from time to time is necessary.

Composition of Manure Mixtures

		N	P_2O_5	K_2O
T/175 mixture	...	20.6	14.75	12.5
Sterameal 'A' mixture	...	6.4	9.2	9.4
Starter Mixture No. 1	...	13.9	17.5	12.0

Weeding

Regular weeding is necessary and all weeds should be hand-picked with the minimum of soil disturbance.

Spraying

During wet-weather conditions, all cuttings and plants in the nursery should be sprayed regularly with copper fungicide, 4 ozs. per 10 gallons of water, at intervals of between 5 and 7 days.

Pests

A periodical check should be made for pests such as Tea Aphids, Thrips, Mealy Bugs, Scale Insects, Yellow Mite, Cut-Worms and particularly White Grubs. Control measures should be adopted when necessary without delay and detailed information regarding control measures can be obtained from the T.R.I. on application.

Summary

(1) The ideal soil for propagation of cuttings is one which has a friable texture, good drainage, and good aeration, as well as a good capacity for holding water. Sands and clays should be avoided. Tea fluff and sub-soil 1:5 has given satisfactory results.

(2) With any large replanting programme nurseries have to be relatively large and soil requirements are heavy.

(3) The time has come to do away with callousing beds and baskets. There are two alternatives—(*a*) bed plants and (*b*) cuttings planted direct into polythene bags.

(4) The pH in the nursery should not exceed 5.0 and the soil should be fumigated routinely for Meadow and Root-knot Eelworm before planting.

(5) The rate of manuring should be 1–2 oz Sterameal 'A' (organic) or ½–1 oz T/175 (inorganic) mixture per 24 plants at least once per month.

(6) Over-shading and over-watering will result in total or partial failure and these operations should be well controlled. Soil and weather conditions should be taken into consideration at all times.

Acknowledgments

My thanks are due to Dr M. T. Hutchinson, Nematologist, for his help and advice on soil fumigation.

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Note on shape of nursery

If the nursery consists of a single very long bed, it will have a footpath all round it, but only one side of the path will be bed. If several shorter beds are used, the footpaths between beds need be no wider, but each will be useful for two beds and thus footpath-space will be saved. With beds 3 feet wide and footpaths 20 inches wide, the most economical shape of nursery will have the bed length in inches equal to 112 times the number of beds. Roughly speaking, the bed length will then be about twice the total width of the nursery. Over one-third of the nursery at least will consist of footpaths; while a single long bed would be more than half footpath. (Ed).

A PRELIMINARY INVESTIGATION OF THE PROBLEM OF MAINTENANCE-LEAF FALL IN THE LOW COUNTRY

D. Mulder

Introduction

Maintenance-leaf fall has been treated in the past as a separate disease of the tea in the low country and the cause has been considered to be *Rhizoctonia solani.* Environmental circumstances and the further effects of the disease on the performance of the bush have not been questioned.

A first attempt has been made in this paper to show what conditions may favour the occurrence, and what the consequences can be in connection with recovery from pruning and the length of life of the bush.

Literature

Petch (1923) described Black Rot of tea in Ceylon as being caused by a *Corticium* species. This name is a synonym of *Rhizoctonia.*

In Monograph No. 2, Gadd (1949) described *Rhizoctonia solani* as the cause of death of mature leaves in the low country.

Loos (1953) observed that what Gadd had described as an uncommon disease had developed into a major problem in the low country.

Webster (1953) thereupon initiated control experiments at Galbodde Estate and Hapugastenne Estate in which two of the treatments were a copper oxide spray and a Bordeaux-mixture spray at intervals of 3 months. These experiments lasted from 1952 until 1954, but unfortunately no definite result was obtained with the spraying treatments. The best results, however, were obtained from thatching. This is indeed very interesting, because it is known that the *Rhizoctonia* fungus comes from the soil and grows up in the bush till it reaches the leaves. What is the influence of thatching? Thatching results in a higher organic matter content of the upper layers of the soil and thereby restores the balance between saprophytic fungi and parasitic fungi in the soil. There is one saprophytic fungus in particular which interests us in this respect. That is *Trichoderma viride* which I recently mentioned in the *Tea Quarterly* (Mulder, 1960) in connection with control of *Poria.* It is known that this fungus, usually saprophytic, is antagonistic to *Rhizoctonia* and can even kill *Rhizoctonia* by parasitic action.

Therefore it is possible that Webster controlled *Rhizoctonia* by stimulating the growth of *Trichoderma* under the thatch cover. In 1953, however, Webster found that *Rhizoctonia solani* had not yet appeared in his experiments (Webster, 1954), but that there was another unidentified fungus. In 1954, *Rhizoctonia* was still absent in these experiments and it was reported (Webster, 1955) that only Brown Blight, Grey Blight, Red Rust and Thread Blight were to be found. The only

conclusion that can be derived from these experiments is that *Rhizoctonia* was not, after all, the main cause of the maintenance-leaf fall.

Shanmuganathan in 1957 had a good result of spraying copper, according to the Annual Report of the Low-Country Adviser (Joachim, 1958), but no recommendation to the planter was made. Now, in 1960, the problem is still there.

Present Work

Last year we started to work on this widespread disease complex in the low country and thanks to the kind cooperation of Dr Joachim, I had the opportunity to gain some experience in this matter. So far we also have not succeeded in isolating *Rhizoctonia*, but we have obtained a culture of a parasitic fungus called *Botryodiplodia theobromae* which can also attack the twigs. It is very likely that several fungi are involved and that regular copper sprays at shorter intervals than 3 months can have a beneficial influence.

It appears however that the control of the various fungi attacking the leaf is not the complete answer. There are several factors which cooperate and finally lead to the weakening, decay and death, of maintenance foliage.

First of all comes the soil. When we compare low country and up-country as regards deficiency symptoms, then we see that magnesium deficiency is common up-country and rare in the low country, apart from some V.P. areas where it occurs due to more liberal potash fertilizing; whereas potash deficiency is rare up-country and common in the low country. This may be due to a difference in fertilizer policy in the past.

Table 1 shows a few potash figures of potash-deficient and healthy estates in the low country compared with those for up-country. At Gallinda, which has very low potash figures, we found severe maintenance-leaf fall and attack by various blights, together with marginal scorch.

TABLE 1.

Potash content of tea leaves

Estate	Condition of bushes	K_2O in ppm of dry wt.
1. St Coombs ...	Healthy	11,460
2. Millakande (just pruned) ...	Healthy	20,436
3. Millakande (one year old) ...	Healthy	17,930
4. Gallinda ...	Healthy	9,961
5. Gallinda ...	Diseased	5,813
6. Enselwatte (jungle clearing)	Diseased	5,109
7. Average Potash content of mature tea leaves according to Eden (1958)	Healthy	13,500–17,600
	Diseased	Below 6,000

Figure 1. THREAD BLIGHT (*Marasmius pulcher* (B and Br.) Petch) Branches and undersides of leaves, covered with threads of mycelium.

On some estates, at least, it is clear that the present application of fertilizer is not able to make up for the existing shortage. A latent or apparent potash deficiency in the leaf, together with a good supply of nitrogen, increases the susceptibility of the plant to various parasitic organisms.

Those leaves which have a latent potash deficiency, without showing actual marginal scorch as a symptom, are very susceptible to attack by parasites. *Rhizoctonia* rot is only one of the possibilities. Grey Blight and Brown Blight spread easily. On the dead leaves which stay hanging in the bush, we get development of Thread Blight (Fig. 1) and Horse-hair Blight. There is also a parasitic Thread Blight known from India which could invade the living leaf, but this has not been found in Ceylon as yet.

The dense mass of dead and living leaf together with the mycelium of the various parasitic and saprophytic fungi create an ideal humid atmosphere for further development of the attack. This situation develops as early as the end of the first year after pruning and by the end of the second year there is little left of the foliage other than the plucking table. This makes it impossible to have a three-year cycle although that might be attractive because of the higher yield in the case of healthy bushes.

Another even more dangerous aspect of the reduction of maintenance foliage due to various leaf rots and spots is the effect on the starch reserves. The question of starch reserves in the low country is always a rather precarious one. Various influences on the bush can upset the metabolism of the plant with the result that the production of starch goes down, or the utilization goes up, so that the bush collapses rather slowly and dies. The method of pruning has already been adapted in the low country because of the low starch reserves in the roots and the frame compared with up-country. What are the effects of potash deficiency and maintenance-leaf fall on the balance between growth and the accumulation of starch?

With the help of the Physiology Division we have examined a number of root samples for starch content. It is well known that up-country you find high starch content; something of the order of 20% depending on the clone and the site. Healthy material from a low-country estate gave 12% starch which is still quite good. Roots from bushes on a potash-deficient estate in the low country, however, gave us figures between 5% and 2% starch, which is very low.

Potassium is still a rather mysterious element but its function in connection with photosynthesis and carbohydrate formation is known. With more potash we expect to get better wood formation, which means more cellulose production, and more potash also means more starch production. It is well known that crops which produce great quantities of starch in their tubers, like potatoes and sugar beet, need a lot of potash fertilizer.

If you increase the potash deficiency by giving more nitrogen, you upset the balance between growth and the production of starch. The nitrogen stimulates protein formation and growth. Thereby a greater share of the starch produced is put into the new growth and the reserves go down. This leads to starch shortage in the roots. If, at the same time, the maintenance foliage is attacked by parasites and falls, the situation might arise in which the whole bush collapses due to starvation of the roots.

If this shortage of starch prevails just before pruning then you can imagine what happens. Some bushes may make a short recovery and then find that they are running out of food. Others may not recover at all.

Even if the most mild pruning system, in which you keep feeders (lungs), is adopted for use on such exhausted bushes, there is a risk that recovery will be bad and die-back at some stage prevalent.

If I were asked to give advice in such cases I would say first of all: get your leaves analysed for potash and perhaps several other elements by a commercial firm so that you know about the nutritional status of your bushes. This puts further action on a better basis.

Second, take warning, if there are acute symptoms of potash deficiency. If there is excessive maintenance-leaf fall, then a latent potash shortage may be present.

Attempts to have a three-year cycle should be abandoned where there is abundant occurrence of Thread Blight, Horse-hair Blight and possibly *Rhizoctonia* or other parasitic fungi.

If you want to take a hygienic measure after pruning, in order to retard the development of these blights, then removal of prunings and a thorough washing of the frames with a copper spray would be profitable. Here we still lack experience, but experiments are in progress.

In summarising, I would like to stress my point that a fatal sequence of events in the low country can be: potash deficiency, maintenance-leaf fall, starch deficiency, pruning, die-back, eventually leading to death of the whole bush.

The policy of neglecting the bush just before pruning can lead to total loss.

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SUMMARY MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON, HELD IN THE GENERAL COMMITTEE ROOM OF THE PLANTERS' ASSOCIATION OF CEYLON, COLOMBO, AT 9 A.M. ON FRIDAY, 2ND DECEMBER, 1960

Present.—Mr F. Amarasuriya (Chairman), Messrs H. E. Peries, O.B.E., C.C.S. (Deputy Secretary to the Treasury), R. A. G. McMichen (Chairman, Agency Section, Planters' Association of Ceylon), B. Mahadeva, C.C.S. (Tea Controller), J. D. Weerasekera, M.P., R. C. Scott, C.B.E., W. H. W. Coultas, R. M. Macintyre, R. J. Gilmour, R. D. Wedd, E. Jayawickreme, D. E. Hettiarachchi, Dr D. L. Gunn, C.B.E. (Director), Messrs G. A. D. Kehl (Administrative Secretary) and H. J. Balmond (Secretary).

Dr A. W. R. Joachim, O.B.E. (Low-country Scientific Adviser) was present by invitation.

Messrs A. V. Richards, N. M. Sanders, H. Creighton and J. L. D. Peiris intimated their inability to be present.

1. **Minutes of the meeting of the Board held on 2nd Sptember, 1960**

The minutes were confirmed.

2. **Membership of the Board and Committees**

(*a*) MEMBERSHIP OF THE BOARD.—The Board received the following reports:—

(1) Mr Francis Amarasuriya had been renominated and Messrs M. P. Amarasuriya and H. R. Fernando had been nominated *vice* Messrs Errol Jayawickreme and J. L. D. Peiris as representatives of the Low-Country Products Association as from 19th December, 1960.

(2) Mr W. H. W. Coultas had returned from leave and had resumed his place on the Board relieving Mr C. R. Webber who was acting for him.

(3) Mr R. M. Macintyre had returned from leave and had resumed his place on the Board.

The Chairman welcomed the new members and those returned from leave, and thanked the outgoing members. He made special reference to Mr J. L. D. Peiris, and recorded his appreciation of the work done by Mr Peiris on the Board and on its sub-committees.

Chairmanship of the Board

Mr R. C. Scott proposed that Mr Amarasuriya should continue as Chairman for another period and expressed, on behalf of the Board, his thanks for the contribution made by Mr Amarasuriya in the past years as Chairman.

Mr R. M. Macintyre seconded the proposal and endorsed the sentiments expressed by Mr Scott. He added that the Director and the Institute appreciated the assistance given by Mr Amarasuriya, and he hoped that Mr Amarasuriya would agree to continue as Chairman.

Mr Amarasuriya thanked Mr Scott and Mr Macintyre and agreed to continue as Chairman.

(*b*) Administrative Committee

(1) Reported that Mr W. H. W. Coultas had resumed his membership of the Committee as from 21-11-60 relieving Mr N. M. Sanders who had been acting for him.

(2) The Board nominated Mr R. M. Macintyre to fill the vacancy caused by the expiry of Mr J. L. D. Peiris's nomination to the Board.

(*c*) Low-country Sub-station Committee

The Board accepted the Chairman's proposal that, in order to ensure continuity in the deliberations of this Committee, Messrs J. L. D. Peiris and Errol Jayawickreme should be asked to serve as co-opted members of the Committee, and that the Board's nominations on the Committee be restricted to one.

Mr D. E. Hettiarachchi was accordingly nominated to this vacancy on the Low-country Sub-station Committee.

(*d*) Buildings Committee

(1) Reported that Mr W. H. W. Coultas had resumed Chairmanship of this Committee as from 21-11-60 relieving Mr Sanders who was acting for him.

(2) The Board nominated Mr N. M. Sanders to fill the vacancy caused by the expiry of Mr J. L. D. Peiris's nomination to the Board.

The Chairman recorded his appreciation of the work done by Mr Sanders on the Committee.

(*e*) Chairman, Agency Section, Planters' Association of Ceylon

Mr R. A. G. McMichen reported that Mr E. F. J. Smith would be succeeding him from 7th December, 1960. Mr Wedd suggested that Mr Smith serve on the Aministrative Committee and that he himself transfer to the Experimental & Estate Committee. The Board agreed.

4. Draft minutes of the Administrative Committee meeting held on 21st November, 1960

Draft Estimates 1961

(*a*) Reported that the Research Revenue and Capital estimates for 1961 (SC. 47/60/1) and the Estate Capital estimates for 1961 (SC. 47/60/2) had been carefully scrutinised by the Aministrative Committee, and had been recommended to the Board for adoption subject to reservation of certain votes pending further details. These details had been circulated to the Aministrative committee and were tabled for the information of the Board.

After discussion the Board approved the draft Research Revenue and Research Capital estimates for 1961, including the votes reserved by the Aministrative Committee and subject to amendments made by the Board.

(*b*) Page 2. Item 3(2). Draft Capital Estimates—St Coombs Estate.—The Board approved the draft capital estimates—St Coombs 1961, and endorsed the recommendations of the Administrative Committee on these estimates.

(*c*) Page 6. Item 5—Institute's Insurance 1961.—The Board endorsed the recommendations of the Administrative Committee for the distribution of the Institute's insurances in 1961.

(*d*) Page 7. Item 6(f)—Supplementary Estimates—Roads.—Reported that the details required by the Administrative Committee were given on Page 5 of Circular No SC. 65/60. The Board noted the details and approved the supplementary estimate of Rs. 4,800/-.

(*e*) Page 8. Item 4(1)—Tenders for Junior Staff Quarters.—The Board approved the recommendations of the Administrative Committee, and on the proposal of Mr D. E. Hettiarachchi, seconded by Mr. W. H. W. Coultas, resolved that the Board's seal be used on the contract documents relating to the construction of these quarters.

(*f*) Page 8. Item 4(2)—Tenders for Laboratory/Administration Block.—The Board approved the recommendations of the Administrative Committee and, on the proposal of Mr R. A. G. McMichen, seconded by Mr H. E. Peries, resolved that the Board's seal be used on the contract documents relating to the construction of the laboratory/administration block.

The Board then approved the minutes of the Administrative Committee meeting held on 21-11-60, subject to amendments made by the Board.

5. Institute's Accounts as at 31-10-60

The Institute's Accounts as at 31-10-60 were approved.

The Board agreed that, as from 1st January, 1961:—

(*a*) all documents presented to the Board and Committees be serially numbered without the letter prefix;

(*b*) statements of the Institute's accounts should be routed through the Administrative Committee to the Board, and that it would not be necessary to prepare separate and subsequent sets of accounts for the consideration of the Board.

6. **Minutes of the Experimental and estate Committee meeting held on 14-10-60**

The Board approved the Minutes of the Experimental and Estate Committee, including the recommendations on the draft Estate Revenue estimates for 1961.

7. **Other business**

SINHALESE TRANSLATION OF MONOGRAPH NO. 4: BY MR W. A. D. WEERARATNE

The Board agreed that everything should be done to spread information on tea and that the translation of Monograph No. 4 into Sinhalese be allowed, subject to proper acknowledgment and to the accuracy of the text being checked, and it was also agreed that the translation should not be regarded as an official translation of Monograph No. 4, and that Mr Weeraratne should be informed accordingly; that he also be advised to revise his translation in accordance with the 2nd edition and that it should be vetted by the official language department.

H. J. BALMOND
Secretary

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